ON FLAT ROOFS, COVERED WITH CLAY AND OTHER SUBSTANCES.

TRANSLATED FROM DALY'S REVUE GENERALE DE L'ARCHITECTURE.

We read, five or six years ago, in a Metz Journal, that a German work, treating of a new system of economical roofing, composed of clay, mixed with other substances, by M. Dorn, Member of the Royal Commission of Manufactures in Prussia, had just appeared. This was the only indication we had of the existence of this work, and we have made many useless endeavours to obtain it, when we lately met, in a Brussels publication, with an extract from a German work, by M. G. Linke, giving full details of the processes of M. Dorn, and the improvements which they have subsequently undergone. From this publication, we now propose to give our readers some highly interesting extracts, the more so, as the original work is exceedingly scarce, and has probably never been seen by any person in this country.

It generally happens that the given dimensions of any elements of construction are but approximate dimensions; some latitude is consequently given to constructors to increase or diminish them, which permits them so to arrange the different dimensions as to render them respectively multiples or parts of each other. This kind of regularity is most valuable in practice: it facilitates at once calculations, designs, and the actual execution of the works; besides which, it assists the memory, and more readily shows the relations which subsist between the various parts which are under consideration. Not to deprive ourselves of these advantages, we have every where retained the measures in feet and inches, as they are given us by the Belgian translator.

"Clay mixed with tan; upon this two or three coats of a mixture of coal tar, rosin, and sand, were the materials which M. Dorn at first made use of. When one of these ingredients has not been obtainable, it has been replaced by others, with equally satisfactory results: indeed, the system has been improved by substituting other tars and various bituminous matters for coal tar, which, whether pure, or mixed with rosin, is not found to be sufficiently durable, on account of the volatile and ammoniacal essences which it contains. By these means the system of Dorn has been in fact brought almost to perfection, though it is possible that the united efforts of the architects who make use of it, may yet originate some further improvements. Common clay suits best for Dorn's roofs; that which is weak and marly has not consistence enough, especially when it is mixed with tan; and potters' earth retains the water too long, hardens with difficulty, and is apt to crack in drying. These defects, indeed, can be corrected by the admixture of sand with it; but the complete union of these materials can only be effected by the application of considerable force, which demands the aid of machinery, whereby the expense of the work is considerably increased.

"It is necessary carefully to pick the clay of all the stones that are larger than a bean; for they not only occasion cracks in the coat of clay and tan while it is drying, but they prevent the composition from acquiring the desirable degree of elasticity, and thus render it less fit to unite with the coat of tar with which it is covered. These stones can be got rid of in a very easy manner by a brass wire sieve, through which the clay, moistened, is made to pass. For this purpose a hole 2 or 3 feet deep, according to the quantity of clay required, must be dug, on the top of which is placed the sieve, supported by props. The clay is then shovelled upon the sieve, moistened, and worked about till it passes through, leaving the stones behind. This operation possesses the further advantage of imparting to the clay the proper consistence for uniting readily with the tan; so that it may always be performed with advantage, even when the clay is already free from pebbles.

"The tan which is mixed with the clay is that which has already served for the purpose of tanning. The greater or less quantity of tannin retained by it is of no consequence, as its only use here is, to lighten the clay and make it elastic. It is used in the viscid state which it acquires from its contact with animal fat. If, however, it possesses so much humidity as to be in lumps difficult to mix up, it must be dried till it is brought to a state in which it can be easily separated by the hand. If the tan, by being exposed to the rain, has become rotten, and thus lost its mobile and filamentous properties, it is unfit for use. The smaller its state of subdivision, the better for this purpose; and therefore the bark from which it is made should have been ground between stones.

"Some say that fresh tan would be more advantageously employed, because this is less liable to rot on account of the tannin which it contains, and would therefore better resist the action of the rain; but experience demonstrates, that the roughness of freshly ground bark unfits it for uniting intimately with the clay, and consequently it becomes more difficult to form, with a mixture thus prepared, that compact and elastic coat which is so desirable. Besides, fresh tan is very expensive, while that which has been used by tanners can be had for a mere trifle. Its rotting, too, is little to be feared, when it is surrounded by clay, one of the best preservers of woody fibre: months of continued rain would not affect it; and indeed, some roofs have remained more than a year before the preservative coats have been laid on.

"However, in place of ground tan, other inexpensive substances may be used for this purpose; such as mosses, marine plants, the refuse of hemp or flax, the rind of oranges washed in lye, or coal ashes. Cowdung, too, it is said, may be used upon occasion. But tan is preferable, after all, to every thing else; and there can be no doubt that when the demand for it increases, it will become an ordinary article of commerce, procurable every where at a moderate price, especially as the cost of its transport is so trifling.

"Coal tar is the most essential and costly article employed in the construction of these roofs. This is a product accessory to the manufacture of coke, or to that of gas for illumination; it must not be too liquid, but must possess a certain degree of consistence. The office of this tar in the construction of clay roofs is most important. It imparts to this covering a solid, elastic surface, impenetrable alike to the rays of the sun, to frost, and to humidity. On account of its volatile nature, it cannot do this long unless incorporated with more fixed ingredients, such as pitch, rosin, and other thick substances which will not dry, and which are insoluble in water. These ingredients are generally mixed with the coal tar during its preparation, in the proportion of from an eighth to a fourth of its weight. The coal tar is thus improved from the thickening it experiences from the action of a slow fire, but this does not render superfluous the precaution of adding to it a small quantity of "arcanson." The different kinds of pitch are for the most part soluble in coal tar of a moderate temperature; the resins, on the contrary, are melted with more difficulty, and thus, for ordinary purposes, we must content ourselves with the pitch of coal, which is cheap, and preserves the layer of clay in general elastic for a considerable time. Nevertheless, as this pitch softens at the temperature of 90 deg. Fahr., and will then stick to the feet, balconies and other places which are to be used for walking upon must be coated with the more expen-

sive resins, and even with common rosin, which does not soften below the temperature of 147 deg. Fahr.

"The mixture of these materials, which should be in the proportion of 5-6ths of tar to 1-6th of pitch, may be further improved by adding to it a certain quantity of ground and sifted chalk, which readily combines with the tar, renders it more compact and less volatile, and forms a firmer and more even coat, and one less susceptible of being softened by the heat of summer. Another composition which may be employed with advantage for a last coat, is a mixture of 1 part of asphalte with 2 or 3 parts of coal tar.

"In order to protect the tar and other materials with which buildings are covered, against the evaporating power of the sun, and to form a solid mass, they should be covered with sand. But this must be completely freed from all vegetable particles, and in general from all matters which float in the water. It must, too, be perfectly dried, and sifted from all large grains; for if it is damp, it will not form a perfect union with the tar; and if it contains any small stones, the pressure of footsteps will force them into the composition, thus forming small cavities. It is thus absolutely necessary that the sand be passed through a fine sieve, and thoroughly dried: as the quantity required is not considerable, this will not cause much additional expense. If the tar is heated by furnaces, the apparatus can be contrived to effect the drying of the sand at the same time. In default of good sand, coal ashes, well sifted, may be substituted. These will cost a little more, but the quantity required is so trifling, that the total expense of constructing a roof will not be materially increased.

"PREPARATION OF THE CLAY.

"To the moistened clay is added a quantity of tan, varying, according to the greater or less degree of stiffness of the clay, from a fourth to three-fourths of the whole volume of the composition. The degree of stiffness of the clay can hardly be estimated by the eye alone, and thence it becomes difficult to estimate with exactness the quantity of tan required; but it may easily be ascertained by experiment. For this purpose a plank, or, better still, a lathed wall, must be covered with the composition, from a half to a quarter of an inch in thickness, and then exposed to a current of air or to the rays of the sun. If the rapid drying thus effected produces none or but trifling cracks, the composition is good: on the contrary, deep cracks, running along the surface of the coat of composition, indicate that there is not enough tan; but where the clay is so stiff, that the tan necessarily forms three-fourths of the whole, it may be mixed with a little sand, only in this case a greater degree of force is required to effect a proper mixture of the ingredients. The tan alone guarantees the composition against cracks, and facilitates its drying, by permitting the entrance of the air and the evaporation of the water. It imparts to it at the same time a peculiar elastic quality, and enables it to absorb the tar with greater facility, and in much larger quantity.

"The proportion of the ingredients being settled, the preparation of the composition is a very simple matter, demanding only a little care and trouble on the part of the workmen; and their labour is much lessened by using moistened clay only. Near the pit whence it is drawn must be formed a kind of vat, 4 or 5 feet long, 3 or 4 broad, and 1 deep. In this vat the soft clay is spread in layers from 4 to 6 inches deep, on which is placed the tan, in layers of 2 or 3 inches. To effect a complete mixture of the two, the shovel and rake will hardly suffice; the workmen should trample it under their feet, and knead it with their hands. By these means alone can the ingredients be perfectly mixed, and the small lumps of moistened tan effectually broken up. For works on a large scale, the same results may be attained by the aid of machinery.

"OF THE LATHING, ITS INCLINATION, AND THE FORMATION OF THE GUTTER.

"The composition of clay and tan is spread upon a foundation of laths or small planks, nailed to rafters. It is essential that the wood be perfectly dry, in order that it may not warp or rend, and that it present a solid foundation, immoveable, and capable of bearing the weight of a man without yielding. It is of little consequence that its surface should be perfectly smooth and level; on the contrary, trifling inequalities therein will cause the argillaceous composition to adhere to it more firmly, and the coat can easily be made level on the outside.

"In rural constructions, the lathing may be formed of cleft sticks, with the ends placed alternately, and the flat sides fastened to the joists: the convex sides thus forming the ground for the plaster.

"A much better but more expensive plan is to nail straight laths, 2½ inches by 1½, to the joists, from a quarter to three quarters of an inch apart. This distance should not be lessened, for the squeezing of the clay through the interstices causes it to adhere more firmly to the laths. Small planks, 1¼ inch by 3 to 4½ inches, may also be used for this purpose; they should be placed the same distance apart as the laths. For balconies and other places used for promenading, planks like these, although lighter, are better adapted than laths, because these last are often knotty, and cut across the grain.

"When these laths and planks are covered with the clay, they are completely protected from rotting, and from the entrance of worms; wood that is liable to the attacks of insects may therefore be employed with safety, such as beech, alder, and birch; but in this case a layer of the composition, half an inch thick, should be applied underneath, though not before the top layer is completely dry. This will cause a trifling increase of expense, but it will make the interior much neater, and with the help of a coat of white-wash, much lighter; it will likewise keep out the cold, and impede the progress of conflagration. Besides which, the interior covering of white-wash will afford the means of instantly detecting any leakage through the roof.

"These roofs may be of any inclination; for on a perfectly even surface, the slightest fall will suffice to carry off the water: 1 part in 100 will be amply sufficient for balconies and small roofs, but hardly so for those of large dimensions, as it is of course desirable to get rid of the water which falls upon them as fast as possible. The degree of inclination should therefore be regulated by the distance the water has to flow, from the highest to the lowest level. Roofs which are to be used as a platform may have an inclination of from 2 to 6 parts in the 100; but in ordinary cases these limits had better be fixed at from 8 to 20 parts in the 100. Too steep an inclination is not desirable,—but the contrary, the size of the roof and the quantity of carpentry is thereby augmented. Besides the increase of expense on this head, there will evidently be much more trouble in laying the coat of liquid tar on roofs having much slope.

"The escape of the water above the cornice may be facilitated by tiles or bands of metal: these last are especially used on wooden cornices, although they may also be employed for tiled ones. When they are intended to adhere to clay, materials of baked earth

are always preferable to plates of metal, which are subject to contraction or expansion on every change of temperature. But on cornices of wood in imitation of stone (fig. 1), and when the ends of the joists project beyond the exterior wall, metal plates answer best. Zinc or iron plates are generally made use of. The zinc must not be too thin: it should weigh from 1½ to 2 lb. the square foot. When it is used thinner than this, which is often done where it is doubled, it happens that this metal not being sufficiently heated at the fold, small cracks are formed in it, which get larger and larger. A single band of stronger zinc must be always preferable to a weaker plate but double.

"These metallic bands may be replaced by tiles, either in one or two rows, carefully closing the joints so as to prevent all infiltration of water, and covering them, to the outer edge, with the clay composition.

"OF THE APPLICATION OF THE COMPOSITION, AND ITS CONSOLIDATION BY MEANS OF TAR AND OTHER SUBSTANCES.

"Every workman employed on the roof is provided with a pail, a trowel, a sprinkling brush, a 6 or 8-foot rule, a common planer, a small pot of water, and a tar brush. An ordinary white-wash brush will not answer the purpose: the bristles must be better fastened in. Common workmen, not accustomed to use the trowel, may dispense with its use, and do the work with their hands. A mason, certainly, with his trowel, will get through more work; but it is so simple, that a common labourer with a little instruction and practice will soon perform it very creditably, and certainly much cheaper than a mason.

"We commence by laying a coat of the clay mixture over the roof. The thickness of this coat, on roofs which are not used for walking on, need not exceed three quarters of an inch: otherwise it must be at least an inch thick. The place where it is applied should be first sprinkled with water, and the composition then thrown with force against the lathwork, and moved about with the trowel, so as to force it into the open spaces: it is then levelled with the planer.

"Everything which projects from the roof, such as walls, chimneys, &c., ought not, as is often the practice, to be encircled with a band of iron or tin, only a notch should be made, into which the coat of composition with which the roof is covered should be forced. This notch should be made a little above the roof, and the composition carefully filled in up to it.

"When the single or double coat of clay is completely dry, a coat of boiling coal tar is next laid on, without mixing it with anything else. This should be done in dry and warm weather, for the tar will not form an intimate union with the clay composition unless the latter is perfectly dry. The application of the tar cold will not answer the purpose; it must be boiling and perfectly fluid, so as to penetrate and diffuse itself through the clay. It must not be spared, but as much laid on as the clay will absorb. It must be poured on with a ladle, and the tar-brush used only to prevent it escaping over the edge of the roof. That it may not cool too soon, it should be heated on the roof, by means of moveable furnaces. The workman must not leave the pot while it is on the fire; and as soon as the liquid tar begins to rise, it must be lifted off by means of levers passing through the handles of the boiler.

"When the first coat of tar is dry, which, in favourable weather, takes place in a few hours, a second is laid on; but this, in order to give it more consistence, should be mixed with a greater or less quantity of pitch, resin, or even asphalte, as has been already mentioned. The second coat of tar should not be applied so hot as the first, that it may not flow so rapidly along the slope of the roof, and that a layer of sand from a twelfth to a tenth of an inch in thickness may be spread over it.

"The roofing thus complete yet admits of more being done to it: it may have another light coat of clay laid on, covered like the first with a double coat of tar. Some consider this operation as an additional guarantee of solidity and impermeability; but it has this inconvenience, that if water penetrates by some imperceptible crack through the upper coat, it will lodge between the two, and find its way at last through the lower one at a considerable distance from the place where it entered, whence it will be exceedingly difficult to discover the original seat of the mischief, and apply the necessary remedy.

"ON THE USE OF CERTAIN MASTICS FOR COVERING FLAT ROOFS.

"For the purpose of rendering this mode of roofing perfectly impervious to the weather, various kinds of mastic have been occasionally employed. The problem to be solved was, to find a composition in which the mixture of clay and coal tar should form a mastic impervious to the rain, and calculated to form a coat which, in hardening, would still preserve elasticity enough to save it from cracking, either by a slight sinking of the carpentry which supports it, or by the weight of persons walking upon it. These essays have been crowned with success, and not only has a clay mastic been prepared, and brought into actual use, but two others also, one made with wood ashes, and the other with coal ashes.

"In making the *Clay Mastic*, we must take pulverised and sifted clay, tan in a filamentous state, and good coal tar; and mix them into a kind of clammy mastic.

"The first two ingredients, perfectly dry, are thrown at intervals into a large boiler placed on the fire, and the tar then poured upon them. During this operation, the whole must be kept constantly stirred. Heat must then be applied till the tar is so thoroughly incorporated with the tan and the clay, that sharp pressure in the hand can squeeze a few drops only out of it.

"The proportion of these substances is as follows:—To a cube foot of clay add from 1½ to 2 cube feet of tan, and to a cube foot of the compound, add 4 or 5 quarts of coal tar. Although in some respects it may be desirable to increase the quantity of coal tar, it cannot well be done, because the composition would in that case harden too slowly, and thus retard the solidification of the upper coat. There is always this inconvenience in the use of this mastic, that it remains soft so long, and gives under the weight of the foot; thus, this method is not suitable for covering places which are used for promenading. However, the addition of a small quantity of sand will partly remedy this defect. In that case we must take equal parts of sand, clay, and tan, and to each cube foot of the mixture, add 4 quarts of coal tar. Some have mixed the tar of wood with that of coal, in the proportion of 10 quarts of the first to 38 of the second. At the same time they have mixed 25 lb. of black pitch with the 48 quarts of compounded tar, and have thrown into it the sand, clay, and tan by small portions at a time, stirring the mixture incessantly.

"The mode of lathing and the formation of the gutter are the same as described above for clay roofs, and the slope may also be the same; but the surface to be covered should be as even as possible, the intervals between the battens or planks should be uniform, and the wood employed in the construction must be perfectly

dry: otherwise cracks would certainly take place in the work. To guard against the probability of rain, the coat of composition is sometimes laid on immediately the laths are nailed down. The only tools necessary for this operation are a large and small trowel, and a kind of flat iron for pressing down and levelling the composition after it is laid on.

"The hot mastic, which is best prepared upon the roof itself, is carried from the boiler in a suitable vessel, poured out, and then spread and levelled with the trowels and planing-iron. When the work stops for the day, the layer of composition is brought to a feather edge, on which the commencement of the next day's work is made to lap, thus making the whole perfectly tight.

"This mode of roofing requires much more pains and care than the preceding. It takes at least double the time, and as the handling of the trowel requires some dexterity, a good mason ought to be employed. Fine, hot weather very much facilitates the operation: cold weather, on the other hand, hardens the mastic too quickly, and gives much more trouble.

"When the coat of mastic is so hard that the footstep leaves no print behind it, a result which, even in the most favourable weather, requires some days to accomplish, a coat of fine sifted sand is strewed over the whole surface, and swept into all the little cracks and chinks which may be formed. The upper covering for the roof is then laid on exactly in the same manner as described above for roofs of clay.

"If the mastic have too much sand in its composition, it is stiffer, and hardens more quickly: in this case it is necessary sometimes to substitute a kind of wooden rammer to level it, in place of the planing-iron: or a common garden roller, weighing from 80 to 100 lb., may be used for the purpose of smoothing it down. Before employing a roller, however, the whole surface should be sprinkled with sand, and it may even be as well to moisten it a little, to prevent the tar from sticking to the roller.

"This method possesses many advantages over the clay mixture of M. Dorn; but it is much more difficult of application, and consequently more expensive.

"The *Charcoal Mastic* is composed of sharp sifted sand, clay dried and reduced to powder, pounded charcoal, and coal tar. This composition was tried upon a roof to which M. Dorn's method could not be applied, in consequence of the advanced period of the season; and it was attended with complete success.

To produce 2 cube feet of this mastic, take 6-9ths of a cube foot of sand, 4-9ths of clay, and 8-9ths of powdered charcoal, and add thereto about 8 quarts of coal tar. The dry materials are first well mixed in a common lime vat, and the coal tar then added little by little. The essential point is, that the whole mass should be thoroughly penetrated by the tar, and no pains or labour should be spared to accomplish this end. It will not do to add a larger quantity of tar: that would make the composition clammy; whereas it ought to feel dry to the hand, and to exhibit no signs of the presence of tar without being forcibly squeezed. The quantity of tar, however, varies, according to the kind of sand and clay employed; the exact proportions can only be determined by experiment at the time.

"The slope of the roof, &c., are the same as for the preceding method: only, the intervals between the laths should be smaller, because the friable nature of the composition has a tendency to cause small pieces of it to break off, and fall between the laths. It is necessary too that the ends of the laths should be fastened to alternate joists, for where they all run together, cracks in the composition are apt to supervene.

"The same tools and modes of application are used for this mastic as for the preceding. The roofing is commenced from the gutter. It is laid on piece by piece, being levelled as the work proceeds: each portion thus forming a base for the portion above it. It can even be laid on in the wet, though there is some risk attending it.

(To be continued.)

OBSERVATIONS ON SOME OF THE DECORATIVE ARTS IN GERMANY AND FRANCE, WITH SUGGESTIONS FOR THE IMPROVEMENT OF DECORATIVE ART.

BY CHARLES H. WILSON, ESQ., A.R.S.A., V.P.R.S.S.A.

(Read before the Royal Scottish Society of Arts.)

THE general promotion of taste is an object of great interest and importance, and materially affects our commercial prosperity. We find it asserted on authority which cannot be questioned, that the principles of taste, as applied to manufactures, are better understood on the Continent than with us; and the subject has been deemed of so much importance that parliamentary inquiries have been made into the causes of our inferiority, which inquiries have been followed by active exertions on the part of Government to promote improvement of taste among the manufacturing classes, by the establishment of Schools of Design in London and elsewhere, also by the passing of a Copyright Bill, by which an effort has been made to protect the authors and proprietors of novel designs from the piracy which has been so injuriously practised.

There can be no doubt that these measures are important steps, and must tend to promote the objects which those who originated them had in view; but we must not rest here,—we must do much more than has yet been done, or perhaps ever contemplated, before we can hope to meet our neighbours without disadvantage in the display of taste. We must not only, as they do, teach principles of good taste in Schools of Design, and defend honest men from the piracy of knaves, but we must also, as they do, form and throw open to our people extensive museums of art, employ the painter and the sculptor to complete the edifices which are raised by the skill of our architects, call in the aid of the fine arts in commemorating the glories of our country, and unite the labours of the artist with those of the historian.

We must, I think, attribute the superior taste which our neighbours exhibit in their manufactures and decorative arts* in a great measure to the advancement which they have made in the fine arts. I have been unable, in speaking of the former, to omit allusion to the latter, and I do not wish to separate them. The divorce which in our day and amongst us has taken place between fine art and ornamental art, has been in many instances fatal to the latter, and certainly has been of no advantage to the former. It has indeed been asserted that taste in manufactures has nothing whatever to do with the state of the fine arts, but the whole history of art proves the reverse of this proposition; and while there can be no reasonable doubt that many of those decorative arts which are more immediately connected with fine art, rise and fall with it; so do I not doubt that every manufacture where taste can be shown, however apparently unconnected with fine art, is influenced by its actual state. It will hardly, I think, be denied that on taste in architecture depends that in house-painting, in furniture, and in iron-work. In every age the forms and ornaments which have been used in these arts have been in accordance with the architectural taste of the time, and, in fact, we can at a glance tell to what period an old piece of iron-work or carving belongs. I have said that a divorce has taken place between fine and ornamental art, and in the medley designs of our house-painters, cabinetmakers, and smiths, the unhappy effects are sufficiently discernible. Assuredly, some centuries hence, should the works of our artizans survive to such a period, they will puzzle the artist and antiquary of those days to decide to which age they belong.

* By decorative and ornamental art, I mean that art which is not usually classed by us with fine art. Neither the expressions nor the distinction are correct; but, as I must make a distinction, I use these phrases for want of more appropriate ones in our vocabulary.

The majority of modern architects leave their works to be completed by the house-painter, and, I may add, the upholsterer and smith, for a house cannot be said to be complete till these artizans have worked in it, and for it.

If the house be Greek or Italian in architectural style, most house-painters on being consulted will recommend its being painted "à la Louis XIV.;" if Elizabethan, they will still warmly advise the Louis XIV.; and if Gothic, they will advocate the same style. The upholsterer thinks of no style at all, neither does the smith. I am not, indeed, aware, that either is ever called upon to furnish a house in accordance with its architecture; such a thing is never, or, at any rate, rarely, and then only very partially, thought of. We shall see in the course of my observations on foreign buildings, whether such is the case in these.

That a house should be painted in any style but that of its architecture is preposterous; we acknowledge this at times in the completion of public or religious buildings. Why should it not be the universal rule; for certainly furniture might be made as comfortable as modern habits require, and still be in harmony in point of form and taste with the edifice: what a charming variety would thus be attained!

It is not my intention to dwell at any length upon the defects of our system; these, indeed, would themselves require more than one paper. It must, however, be said, in justice to our citizens, that what they have done is wonderful. When we consider the actual neglect with which their interests have been treated, their merit is very great; indeed, they have done as much as it is possible for mere artizans to do, and have carried some of the ornamental arts to as high a perfection as can be attained by men who have not the education of artists, and who are not instructed by their example.

I repeat that I cannot omit all mention of fine art, though the present paper bears a title which might authorize the supposition that I intend to confine myself exclusively to descriptions of arts which, according to our present mode of thinking, have no connection, or, at any rate, a very slight and distant one, with the *fine arts*. As I mean to endeavour to show that the contrary is the case, I shall briefly touch upon the state of our School of Art, and offer a few observations upon the state of taste in this country. I shall then glance at the state of art in Germany and France, and contrast the system adopted in those countries for the encouragement and employment of art with that followed in ours.

The history of the fine arts in Scotland is very remarkable. We have seen a school struggle into very considerable excellence under circumstances of discouragement and neglect unparalleled in the history of art. Our public is very ready to congratulate us on this advancement; but the chief merit is the artists', and the public is very far from being entitled to any great share of it. Art could not exist at all without some encouragement; but if so much has been done by the artists with so little aid, what might have been done had there been a more general appreciation of the importance of the fine arts? The public, generally speaking, are by no means so far advanced in point of taste, as the state of art in this country should have made them. We may easily form a judgment on this subject by our intercourse with society, in which even a moderate knowledge of art will be found to be confined to a very small minority. Then, if we turn to our press for proofs of knowledge, whilst with one or two exceptions in London the lucubrations in our papers are too frequently beneath contempt, our more important journals almost entirely neglect the subject; and this neglect is a sufficient proof how little it is in reality valued, or even thought about.

But I hope that we may now look forward to better times; every where there are indications of improvement. There seems to be an increasing desire on the part of the public to see art encouraged. Institutions have been established, and societies formed, with this avowed object, and so far it is pleasant to contemplate this; but these very efforts, although made in an admirable spirit, are misleading us. We congratulate ourselves on our exertions, and believe that we are exhibiting an earnestness in the promotion of the fine arts worthy of our place amongst civilized nations; but I greatly fear that, from the very nature of the means which we are adopting, and from the want of just ideas on the subject, whilst some good is effected, we are also ministering to all the evils which afflict our school,—we are fostering and perpetuating a system which would be thought the invention of insanity, if followed out by any student for any other profession, but which is apparently thought the most suitable preparation for becoming an artist.

Have we made a single effort of importance to establish a proper school for the due education of artists? The fact that we have not, is a sufficient proof that we have not thought it worth while. It is true that in this town a magnificent establishment exists, but it was founded with different views; and, besides, it will hardly be maintained by any reasonable being, that a few hours' teaching in the week, and permission for students to draw during the day, without any guidance whatever, is sufficient; would such a system make either lawyers or physicians? The artist alone is left to grope his way almost unaided. I am, indeed, no friend to any mere academic system for the education of artists, but such would be much better than none at all; and as we can hardly hope to see the old system of schools restored, I should be glad to see an academic school amongst us offering certain advantages to the student, whilst the disadvantages of the system might in some respects be avoided.

The artist in this country has thus two great evils to contend with; in youth, the want of the means of education—in manhood, the want of proper and well-directed patronage. Private patronage can create a very excellent school of art, but it cannot create what we term a great school. We must have that of the state, and also that of municipalities; I would willingly add also that of the church, but that is very hopeless in Scotland. I am certain, however, that if the state finally patronizes art (and I am thankful to think that there is now a certain prospect of its doing so), our municipalities will follow and do so also. We should then see our artists called upon to design, not only great historical works, but also works which would bear more directly on mere ornamental art, than the production of pictures alone can possibly do, and which would, therefore, tend to its improvement; and, as I hope to show you by my subsequent observations on foreign art, whilst the artist would profit in every point of view by such employment (his field of study, for instance, would be greatly extended, which would unquestionably tend to the general improvement of fine art), the position of the ornamentalist would also be greatly improved; more ability and cultivation would be required in his department; and as juster ideas of art would soon prevail, young men would not so readily esteem themselves fit to be artists, as they do now on very slender grounds, but would continue in departments of art which would offer them secure subsistence, rather than embrace the miserable and hopeless career of the mediocre artist.

In my late continental tour, my express object was inquiry into certain processes of painting; but although much occupied with these, I still had time to give a passing glance to other interesting subjects so closely connected with the particular objects of my journey, that I had merely somewhat to extend my observations partially to embrace these also.

The King of Bavaria is the greatest patron of art now living, and in his capital we may see numerous proofs of the results which a well-directed patronage of the arts can produce. The Bavarian artists now enjoy an European reputation, but it is much to be regretted that the zealous praise of some of their admirers amongst ourselves has raised a feeling in some of our artists, which displays itself in *discreditable* abuse in those journals, the pages of which are particularly devoted to art; thus we have on one side an admiration which, although just, is too exclusive, and on the other, criticism, which is intemperate and ungenerous.

No comparison whatever can at present be instituted between the leading artists of Germany and those of this country: when our artists are, like the former, employed to paint national monuments, then we may institute a comparison, but, at present, none can with justice be entered upon. To paint a single historical work, however large it may be, is one thing, but to paint a series for a particular building, is quite another; it is possible that an artist may succeed in the single picture, yet fail in the series. Where a comparison can fairly be instituted, and that is between the cabinet pictures, landscapes, and portraits of our school and of theirs, I think that it cannot be doubted, that, in many respects, our artists have the advantage, and we may entertain a warm expectation of success when they are called upon to execute works of equal magnitude and importance with those of their continental brethren.

The King of Bavaria has resolved that his capital and dominions shall contain monuments to rival those erected by the magnificence or piety of former days, and he has to a wonderful extent succeeded in his object.

The manner in which His Majesty meets his artists is interesting, and offers, I think, a useful lesson to our amateurs. When he has resolved on the erection of a new church, or other important edifice, he summons an architect, painter, and sculptor to his presence, and explains his wishes to them either separately or together; when the plans are ready, the artists again meet their sovereign, and a council is held over them; he encourages them freely to express their opinions, even when contrary to those expressed by himself. When everything is thus at last decided upon, the work is commenced and goes on without interference; and should any part of it prove less successful than was expected, there are no reproaches, for the King at the previous council took his share of responsibility.

It will be easy to conceive that such a monarch is spoken of with devoted attachment by the men he thus employs, and that he is served with enthusiasm. Many express surprise that the King of Bavaria should have been able to carry on and complete such varied and extensive works, when it is known that the resources of his kingdom cannot be very great; but he is aided by the devotion of his artists, who accept of moderate sums for their labour; many of them will leave immortal names, but few of them indeed will leave fortunes.

I beg that it may not be thought by these expressions that I am of opinion that art should ever be poorly paid. I hold a very opposite opinion; it ought to be well paid, but not extravagantly, as some seem to think. I regret to think that, in our country, public undertakings are so frequently viewed by individuals employed in them as sources of immense emolument; hence an outcry, hence opposition to every undertaking that is not of the most utilitarian character, and the apprehension of extravagant cost frequently deters from many undertakings that would be beneficial to art.

I admire the Bavarian artist who is content with the emolument which his king can afford to give him, and who undertakes works at a moderate price for the love of art and the honour of his country; and this spirit prevails amongst all who are employed, amongst artizans, as well as artists. The Chevalier Klenze, the king's principal architect, informed me that the operatives bestowed so much time and labour upon every thing that they undertook for the king, that in the earnest desire to make their work as perfect as possible, they seriously impaired their profits. These are interesting facts, and assist, at any rate, in explaining how so many works are done, and so well done.

The tendency of the Germans in art has been much misrepresented in this country, and we have heard it repeated, "*usque ad nauseam*," that they are mere imitators of the very early masters. This is not true. I shall not enter at large upon this subject, but beg to refer you, for what I believe to be a true view of it, to Mr. Eastlake's admirable paper at the end of the last report of the last Parliamentary Committee on the Arts.

In architecture, I am not disposed to consider our friends so favourably;—there is much genius evinced in their productions, their conceptions are great, and magnificent works are undertaken, and brought to a successful termination, but their talent is chiefly shewn in very direct imitation, and that imitation is not always discriminating; there are many very tasteful revivals of the middle age Tuscan, of the restored Italian classic, of the Byzantine and Romanesque, but, at the same time, there is also a revival of the principal defects of the Italian architects; and I do not think that much judgment is always shewn in the choice of a style. The famous Ludwig Strauss is wholly ineffective as a street; the style of most of the buildings is that of the fortress palaces of Tuscany, and the imitation is not at all times successful. The material, however, is excellent, and so is the workmanship; the details are generally in beautiful taste and admirably executed, and the decorative completion of the buildings is ever in a style of great magnificence.

The few attempts in Gothic are coarse, and almost entirely devoid of all true Gothic feeling; and it is remarkable that the details which, in edifices in other styles, are better than the general designs, are, in the Gothic attempts, very indifferent and inferior to the conception of the mass.

I do not think that the Bavarian School of Sculpture has any very high claims to excellence. The word clever seems to me the most applicable to the works which I saw at Munich. There is no want of employment however. In the new throne-room of the palace, there are twelve colossal portraits of ancestors of the king, in gilt bronze; the Tympana of the Walhalla, the Glyptothek, and portico opposite, are filled with statuary; and I might mention much besides; but the most extraordinary undertaking of all, is a statue of Bavaria, now modelling, and which is to be cast in bronze. It seems to be about fifty feet high; and I saw several young sculptors perched on different parts of it, or slung with ropes, chipping away at the plaster of which it is formed, and shaping it with small pickaxes as substitutes for the usual modelling tools.

Whilst the fine arts in Munich are flourishing, the decorative arts which are connected more immediately with them are in a very advanced state. The house-painters of Munich are excellent artists, and paint cleverly in oil, fresco, encaustic, fresco secco, a peculiar art imported from Italy, and in common distemper. The reason of this ability and advancement is evident. The arabesques and ornamental painting in the palace are all designed and executed by eminent artists, and so it was in the best ages of art. Thus, an example of fine designs, correct and appropriate taste, and excellent execution, is set to the mere decorative painter, many of whom, indeed, are employed as assistants, and thus study their art under the most advantageous circumstances. The reason of our inferiority in this department is thus rendered evident, and all efforts to place ourselves on the same level with these artists will be vain, till we see the same system adopted.

The execution of ornamental architectural details at Munich is also excellent; there is no art in which we are more deficient than in this, as is sufficiently evinced in the hard, stiff, and lifeless character of our architectural ornamental details of every description.

I was also much struck with what may be termed the decorative carpentry, or rather joinery, at Munich. I am enabled to shew you some examples of the beautiful flooring of the palace; the cost is, however, considerable, about 3*s*. 4*d*. for every 18 inches square, which would make a cost of £100 for a room 30 feet square, although machinery is used in the formation of the pieces of which this mosaic work is formed. The doors also of the palace are beautiful specimens of taste and workmanship; they are about 10 feet high, and formed of various fine woods inlaid in beautiful patterns and highly polished; each door costs £18. I have not seen any thing to equal them in any other royal residence which I have visited.

Metals, also, are wrought with great taste and skill; and in ornamental work, attention is paid in the design to the *nature* of the material, which is too much neglected by our designers, amongst whom forms borrowed from those of stone-work are generally used in iron.

I purchased, for the use of our School of Design here, a number of examples of ancient iron-work, made in the workshops of Nuremberg, and which unquestionably excel both in taste and workmanship the boasted productions of our day. It is perhaps impossible to restore, for all purposes, the old modes of working iron; but although we must submit to the trammels of casting processes, yet in designing even for these, just principles of design may be introduced, by paying more attention to the nature and capabilities of the material.

I now beg to call your attention to another important art which has been restored and is practised with much success in Munich—I mean that of glass-painting. Before entering upon a description of it, I would beg such of you as have seen them, to recall to your memories the noble specimens we possess in some of the cathedrals and ancient churches in the south; I would mention the fine windows of Cologne Cathedral, but especially those of St. Lawrence in Nuremberg, in which church the Volkamer window may be mentioned as, in all probability, the finest in the world. The art has never been lost in Nuremberg, and I am happy to shew you a copy, by the best artist of that place, of a portion of the Volkamer window. You observe that we have here a figure of St. Catherine, admirably drawn, and she is placed over a Gothic pattern or ornamental design, which runs through the greater portion of the

window behind the figures. You have here a specimen of the true system on which such subjects on glass should be designed. These should be treated in a conventional manner; no attempt should be made to represent nature, as we do, for instance, in a picture, as thereby the idea of a window is immediately destroyed; many of you who have seen it must have been struck with the bad effect produced by this mode of painting a window, as seen in St. George's Chapel at Windsor, in St. John's Chapel here, and in the Parliament House. Notwithstanding the just criticism with which these have been assailed, glass-painters, both in the south and amongst ourselves, persist in copying pictures for such purposes, so little do they understand the principles of design, as applicable to their art. I saw in London a copy from Rubens' Descent from the Cross, being executed for a church, and I might cite many other examples of this perversion of taste.

Now, the glass should be painted with architectural ornaments in character with the architecture of the church, and those should be correctly coloured in imitation of ancient painted examples of church architecture. Some of you are aware that both the exteriors and interiors of ancient buildings were richly painted. It was thus in Egypt, thus in Greece, and such was the practice in ancient and Gothic times. It was a practice which, I believe, was abandoned when the principles of taste were better understood, although I say this with caution, and it would be foreign to my subject to enter upon this interesting question. The architectural and ornamental design, then, in church windows, in the particular examples which I bring before you, seems to be a representation, in brilliant colours, of the painted architecture of the period, and over these are painted the figures, whether of holy personages, saints, or heroes.

The architectural ornaments or design fill the whole window, and the figures are drawn and painted in a severe manner, without any affectation of pictorial effect as to light and shadow.

To give you a more distinct idea of my meaning, besides these specimens of painted glass, I exhibit a coloured engraving from one of the windows of the Au Kirche at Munich; in this specimen the true principles of design, as I view them, have been adhered to with considerable fidelity, although such is not exactly the case with all the windows in that church.

I have made these brief observations upon this important subject, because, as far as I can judge from the examples which I have seen, neither in London or any where in this country, is the art of designing for glass-painting yet understood. The windows which you frequently see executed of pieces of stained glass arranged in patterns, cannot be criticized as specimens of the art at all; those in which ornaments are painted are very far from satisfactory, and as to the copies of ancient masters, from Mr. Martin's coloured prints, the prints of noble lords, &c. &c., the sooner these are sent to the glass-house, to be melted for some useful purpose, the better.

There is a school of glass-painting at Munich, fostered by the king with the utmost care. Professor Hess, one of the most distinguished of the Bavarian artists, is inspector, and under him there is another accomplished artist, who makes the principal designs, and directs the works.

We have here the secret of the superiority of our neighbours in this and, as I have shown you, in other ornamental arts. What are our glass-painters as compared with those of Munich? Instead of being accomplished artists, they have hardly a claim to the title at all. We complain of the imperfection of many of our decorative arts, but how can it be otherwise? They are chiefly practised by individuals who, however meritorious, have little claim to artistic knowledge. The establishment of a school of design in every town in the kingdom will not mend this; the use of schools of design is to educate persons who may execute the designs of artists. To make designers, as is expected by many, except for inferior purposes, is impossible. A classical education, a perfect knowledge of the history of art, in fine, an educated mind and a refined taste, are necessary to the designer for important ornamental works; and till it is made worth while for the professors of these to follow the art, and till such persons are employed, we must, of necessity, make what efforts we may, be behind our neighbours in these ornamental arts, since they avail themselves of the services of the finest talent within their reach.

To return to the Munich School of Glass-Painting. The Director first prepares full size cartoons; these he paints in water colour (and I have nowhere seen more beautiful drawings): other cartoons are then prepared which may be termed maps of the colours; these are coarsely executed, but correctly tinted; the simple colours only are indicated; thus a red robe is painted of a flat red, the shades being left out, and so on with the other colours. This map, so to speak, is put into the hands of the glass-cutter; he matches the tints from his stock of coloured glass, and cuts it to the shapes. This process requires much practice; many of the pieces are very small and of somewhat complicated shapes; he must also allow for the leading, or uniting by means of strips of lead, as you see in this example.

An ingenious instrument is used for cutting large portions of circles, of which I exhibit a drawing.

The coloured and white pieces being now united with lead in the usual way, pass into the hands of the artist, and are painted. A mystery is made of the preparation of the colours, and I was not allowed to make any inquiries; but this mechanical part of the art is, I believe, well understood amongst ourselves. After the painting is completed, the lead is taken out, and the pieces of painted glass are put into the stove, of which I have made a sketch from memory. An old man from Nuremberg superintends this department, and is the only person in the establishment who has the requisite experience.

The encouragement given to the art which I have just described, has led to great improvements in the manufacture of glass, and the optical instruments of Munich have now a high reputation.

In France, I was also chiefly occupied inquiring into processes of painting, and I had little time to see to other matters. I cannot venture to offer you more than a few very general observations on the arts of this great and interesting country, but I shall bring under your notice a few facts which bear upon the subject which I have been attempting to illustrate.

Art is extensively patronized in France, and frequently with political views. The patronage, however, is not always judicious, and the very frequent changes of government which have taken place of late years, in France, has led to this. The patronage of the throne, which is very extensive, has been more steady and has produced great results, whilst that of the ministry has never been on any well organized plan, and to this most of the faults that have been committed are to be attributed.

Whatever may be the objections to some details of the system, art is extensively patronized in France by the throne, the ministry, and the municipalities, and great has been the progress that has been made.

I might give you many examples of the munificent care with which the French government watches over and promotes the welfare of art; I might describe to you that magnificent establishment, the Ecole des Beaux Arts at Paris; but I must content myself with a brief notice of that most important of all establishments, the French Academy at Rome.

The French Academy occupies the Villa Medicis, with its fine and extensive garden on the Pincian Mount. One of the most distinguished of the French artists is sent to Rome as director, his office enduring for five years; he has fine apartments in one part of the villa, and entertains during winter.

I do not know how many pupils are sent or how long they remain, I believe five years; but this is of no consequence to the view that I am at present taking. The whole cost of the establishment is 100,000 francs, or £4000 sterling per annum, of which 20,000 francs are expended in travelling expenses during the hot summer months, when the pupils leave Rome (then unhealthy) and visit other parts of Italy.

The students are required to be at home at meals, unless they have the permission of the Director to do otherwise. They are also required to keep regular hours, to be studious and diligent,—and to secure this, tasks are allotted to them. The young architects, who study monuments of antiquity, are provided with scaffolding, ladders, and every convenience, and the painters and sculptors are equally cared for; and, lastly, the Director regularly sees company, generally composed from the best native and foreign society, where the pupils have every opportunity of improving themselves in this agreeable and refined intercourse.

Contrast this with the English system. Every three years a travelling student is sent abroad, and he is thrown into a position, for

profiting in which he is often wholly unprepared by previous education; he is generally quite ignorant of the history of art, or of any art but that which he has worshipped in the Academy, and is probably prejudiced against all other; he is, in fact, sent to Rome, provided with funds, and perfectly free to follow any course he may choose, without any guide at the very time he most needs one. The result may be anticipated, and I believe that very few of the travelling students have arrived to any eminence; whilst, on the other side, many of the most distinguished of the French artists were students in this Roman establishment.

I was assured by the Directors of the Museums in Paris, by M. Ingres, late Director of the French Academy, and by M. Conder, that they considered the French Academy in Rome as one of the most valuable and useful of their national institutions for the benefit of art.

I have contrasted the French system with ours, and this is one of those unpleasant contrasts that we are obliged to make; but still, be it observed, we have in our plan another instance of artists doing what they can for the benefit of art, unaided either by the public or the government of the country.

I am unable, as I have said, to give you any detailed account of the arts and manufactures of France; to do so would also be beside my subject. We have, however, much need to be up and doing. We have admitted the superiority, in point of taste, of many of the French manufactures, but we have claimed for ours great superiority of fabric. This, Sir, in many respects, is fast becoming a fallacy; and as the French have greatly excelled us in taste, they are now, in many cases, equalling us in fabric.

I found in the Italian ports our fine woollen cloths and printed goods comparatively unsaleable, because the French goods were much superior. I was informed, that, in America, their glass manufacture, because of its superior beauty, has the advantage of ours in the market; and I have particularly to mention their astonishing progress in cutlery, in which almost a short time ago they were, almost to a proverb, deficient. They now produce various articles, which, in appearance, at any rate, are equal to our own. We ought to take these things into our serious consideration.

But to return to my more immediate subject.

Great additions have lately been made to the Hotel de Ville of Paris; and the public apartments of the Lord Mayor, if I may so call him, have been painted by some of the most distinguished of the French artists, amongst whom I may mention Mon. Vauchelet, to whom two of the rooms have been entrusted. In one he has painted, on pilasters of polished white Scagliola, a series of exquisitely designed arabesques; his subject is continued in the frieze and terminated in the ceiling; the other rooms are appropriately and magnificently decorated also. In this building we have an instance of well-directed municipal patronage of art; and a number of churches exhibit, at the same time, instances of the munificent patronage of the worthy magistracy of Paris.

In the Chambre des Pairs, and in that des Deputés, and in a number of churches and public buildings, we see the results of the efforts of the French Government. At Fontainbleau, Versailles, and in the Louvre (and I daresay elsewhere), may be seen a prodigious number of works of art executed by order of his Majesty the King of the French. To give you some idea of the extent of the works carried on at Versailles, I may mention that I was shewn by my friend, Monsieur Neveu, the king's architect, 60 large portfolios of the drawings for the works now in progress.

I have endeavoured to shew you, in these brief observations on German and on French art, what are the true causes of the superiority of these nations in the decorative arts.

It must be perfectly evident to you that palaces painted by accomplished artists, must be in better taste, better done, and far more complete and interesting, than those like ours, in which, after the architect has closed his labours, the house-painter and upholsterer are alone consulted. This is so evident, that I need not detain you further with many arguments on this portion of my subject.

But our neighbours go farther in this decorative employment of artists. I saw one of the most able of the Parisian artists designing ornamental tapestries for the palace, to be executed at the Gobelins. You will remember that Raffaelle did the same, and our finest possession are some of the cartoons which he prepared for such a purpose.

The works of artists are, in fine, the very sources from which all our decorative artists draw their examples, and their jumbles are chiefly made up from the arabesques of the Vatican, those of the palace of the T at Mantua, and the well-known designs of Watteau. We shall have nothing new, not even an appropriate application of what is old, till, as of old, and as now in Germany and in France, the most able artists we can command are employed in such departments of art.

The tradesman need not be jealous of this employment of the artist. There can be little doubt that were artists employed to paint, and to direct the painting of our royal and other palaces, that the taste for such decorations would rapidly spread over the land, and the employment of the tradesman would be increased a hundred-fold; whilst, by the diffusion of taste, and the increase of skill on the part of our workmen, that which is now far too expensive for many to adopt, would then be brought within the compass of their means.

By the employment of artists, the taste of the nation generally would be greatly improved, and I have no doubt that we should soon be enabled to meet our neighbours in those wide fields where we confess that they have beaten us, and there can also be no doubt that our commercial prosperity would be thereby increased.

Before concluding this paper, I shall briefly bring before you one plan which would, I think, greatly aid in promoting taste in manufactures amongst all classes.

I have endeavoured to shew you that, without a more general employment of artists, we cannot hope to rival our neighbours. I have also said that, like them, we must open museums to our people, and increase the numbers of our schools of design.

With regard to museums, our attention has been almost entirely directed to the accumulation in these of precious works of art and of antiquities, but no one seems to have thought of the accumulation of specimens of ancient industrial art, and also of foreign manufactures. To make artists, and to cultivate taste in the fine arts, we have purchased the Elgin and other marbles, and we are slowly forming a national gallery. We do not think it necessary enough to provide our young artists with casts of portions of statues, and with prints from pictures; we procure for them real Greek and Roman statues, and real pictures by the great masters, and we do well. Now, Sir, I would propose that we should carry out this principle in our efforts to promote taste in manufactures of every description; let us form museums in which the citizen may see, free of all cost, specimens of ancient iron-work, wood carving, glass-painting, and of such arts as were successfully practised in ancient times, of which examples still exist; and to this museum let there be yearly added specimens of the novel and tasteful inventions of our clever neighbours and rivals, so that we may have an opportunity of knowing what they are about, and of comparing our efforts with theirs.

I was influenced by such thoughts as these, when I purchased, for the Honourable Board of Trustees for Manufactures, the objects which they have obligingly permitted me to exhibit to you. I have formed the nucleus of such a museum as that which I advocate. You may observe amongst these, specimens of iron-work centuries old which (as I have already remarked) excel in taste and workmanship all the productions of our days; also a lock of ancient date, which I am told is a miracle, both of workmanship and inventive skill.

There are also a few specimens of carving, of ancient glass-painting, and some of tasteful modern German manufactures; there are not many of these, but they are all pleasing examples of taste and skill, and I shall, by their exhibition in our school of ornamental design, give the pupils a better idea of the various arts exemplified in these specimens, than if I were provided with all the prints that ever were published, and were to lecture from morning till night every day of the year.

I have briefly attended to a plan, for which I trust to have the support of your opinion, as one which will be greatly conducive to our advancement in the arts.

CHARLES H. WILSON, F.R.S.S.A.

Edinburgh, *28th March*, 1843.

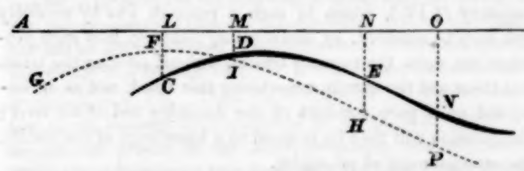
OBSERVATIONS AND RESEARCHES CONCERNING THE PROLONGATION OF THE LINE OF RIVERS INTO THE SEA.

TRANSLATED FROM THE ITALIAN OF ANTONIO MARIA LORGNA.

BY W. MULLINGAR HIGGINS, ESQ., C.E.

In the year 1772, finding myself at the entrance of the Adige, in the ancient and decayed port of Fossone, I was anxious to measure four sections in remarkable situations at the mouth of the river, before it leaves the last alluvions of sand which enclose it, to spread and mix with the waters of the sea. Not having on those coasts, at the time, a firm point to which to refer the level of the water, I waited the low tide of the Adriatic, and to that reduced the depths I found. I took notes of the soundings found in every section, as well as of the depths compared with each other, which I deduced from them, as, another opportunity offering, I might, after some years, be able to repeat the observations in the same situation, and obtain some advantage from a comparison of the results.

In the year 1776, having engaged to take a view of the Adige, of which work I shall probably be able to give an account at some future time, I remained two days at the mouth of the river, in the company of a gentleman who is very studious and learned in such matters. While he was engaged in drawing the river and its surrounding country, I employed myself in taking the soundings across the river, on the same spot as in the year 1772. In consequence, also, of the low tides on this occasion, I reduced the depth determined by the new soundings to the same horizontal line as was employed in the first series of observations, having regard to the difference of times and the depressions of the sea, the ebb as observed in 1776 being greater than in 1772. The result of these observations is exhibited in the following Table, as well as in fig. 1, in which the horizontal line AO is the level of the low tide of the Adriatic Sea.



Sections.	Mean depth in Venetian feet in 1772.	Sections.	Mean depth in Venetian feet in 1776.
1. L C	3 0 1	1. L F	2 0 0
2. M D	1 10 2	2. M I	2 9 10
3. N E	2 10 6	3. N H	4 1 7
4. O V	4 2 0	4. O P	5 9 1

In comparing the two sections of the same place in the years 1772 and 1776, it is necessary to make an observation in relation to the mouth or entrance of the river. In 1772 it was cut into three branches: one turned towards the north-east, another towards the east, and the third towards the south-east. In the short period of four years the entrance towards the east was quite closed by earthy matter; that towards the north-east was dry at low water; the south-easterly channel was the only one open in 1776. These are remarkable changes produced in the entrance of this river in so short a period of time, both in regard to the depth of water and the position of the discharge into the sea.

I. Then we deduce:—

1. That the bank or bar common to the mouths of all rivers continually advances into the sea, and the trunk of the river is extended.

2. That where there was shallow water in 1772, shown in the 2nd section as 1.10.2, there was in 1776 a depth of 2.9.10. So also in the two sections immediately above there was a deepening of the channel, of 1.3.1 in the third, and of 1.7.1 in the fourth.

3. That in consequence of the river being deepened after the year 1772, the waters were collected, the branches were absorbed, and out of three was formed one mouth into the sea.

II. These changes, I believe, are common to all the rivers which discharge their waters into the sea, and, more or less, keep open their discharge for a short period of years, according to the course of the waters, and the detritus with which they are loaded; according to the position of the entrance in reference to the winds; according to the depth of the sea into which the rivers flow to discharge themselves, and the force of other particular and local circumstances; but at first there does not seem to be any other work of nature to observe than the prolongation of the line of the river into the sea. So it is, in fact, if we only superficially consider the thing; but, by a closer consideration, one may perhaps, from these observations, deduce much more than might at first be anticipated. The accident of having made my observations within the short period of four years, may not be unproductive. It is often useful to seize nature in her work, it being much more easy to discover her artifices in the act of the operation, than when the operation is completed.

III. Let us then consider the observations combined, and compare them together. Experience shows, that in the advance of the debris carried by a turbid river towards the sea, and in the successive changes and prolongations of the shallow beds, the waters in the contiguous parts and immediately above diminish in width, and more than ever enchannel themselves in their own alluvions. Then by necessity the depth increases. In consequence of this, the concavity of the lower trunk, observed in all rivers, also advances, and is re-formed where there was before an elevation or bank. The acclivity of the ground also in the advance of the bank into the sea, is displaced, and reproduced in a more forward situation, so that there is a successive change of the concavity into an elevation, and of the former elevation into a concavity. Fig. 1 represents this progression. The horizontal line AO represents the low tide of the sea; CDEV, the first position of the bank; GFIHP, the second. The elevation that was first in D has passed to F; the acclivity VED has moved forward to PHIF.

But having placed all this in the lowest trunk, what are the successive alterations produced in the trunk immediately above, where we know in this, as well as in all other rivers, the bottom has very little or no declivity, till the horizontal line meets the low ground of the mouth. What then is the change in the trunk, or in the declivity of the ground?

IV. It is generally thought that one must distinguish the elongation of the line of turbid rivers with an inclined bed, from that which happens in rivers with a horizontal bed. Every one agrees that, in the former case, the elevation of the bed must be the result; but not so in the second case,—in a horizontal bed,—where the force of the water is sufficient to push on the detritus, and transport it into the sea. Guglielmini, the most profound of all the the Italian writers upon this subject, avoided giving a decided opinion upon this question. "Whether the prolongation," he says, "of the line causes the elevation of the beds of those rivers which run almost horizontal, we cannot decide." This philosopher foresaw that an alteration was also possible in rivers almost horizontal; but not having, probably, either his own observations at hand or those of

others, in the infancy of the doctrine of rivers, he suspended his judgment. But, whatever may be the result, this distinction, instead of opening the way to inquiries, or answering the questions in the previous section, involves the argument in great difficulty.

If it be denied that the elongation of the line does raise the bed of an almost horizontal channel, supposing that the elevation of the inclining beds is not doubted against principles the most certain and all experience, the subject becomes very obscure. This is certainly a question deserving the most serious examination of hydraulic engineers.

V. It seems that the doctrine of horizontal channels is not sufficiently developed, for the opinions we have stated, given to us by the most esteemed authors, when applied to the subject, do not generally agree with facts. It seems, in the first place, that they make the distinction, already mentioned, between the channels with an almost horizontal bed and those with an inclining bed, as if the one were distinct from the other, or as if each could be separately considered, which, in turbid rivers, of which we speak, cannot with any propriety be done, without mutilating the system of those rivers having inclined beds, and denying the existence of those causes by which, in certain circumstances, they may not only become horizontal, but also raised; they give rise to most difficult questions as soon as an attempt is made to separate their effects.

From what source is derived the idea of turbid rivers with horizontal beds? Certainly from the consideration of the last trunks towards their mouths;—from that of trunks caused by sluices, which are, in a certain respect, equivalent to the real mouths—and from similar conditions of rivers. In fact, constant observation shews us, that having drawn a level from the bed above the mouth, or from the top of the bank, a great part of the superior bed of the river lies beneath this horizontal, and the effect of the discharge is to cut the bed in some part more or less distant from the mouth according to the greater or less body of water in the river, according to the nature and quantity of the detritus which it transports, and the influence of other conditions of the channel, which together are very complicated. This disposition of the beds necessarily involves, in such trunks, the passage of a declining bed into a rising one, and some modification of the intermediate horizontal bed through which this passage is produced. This intermediate bed has a very short course in small rivers, in which the horizontal line touches the superior bed at a short distance from the mouth; but in large rivers, the space between the mouth and the interception with the horizontal bed being larger, and the greatest depression of the bed under it falling comparatively nearer the mouth than the section above spoken of, it follows, that the rising trunk is also incomparably shorter than the other, and, in consequence, the space of little or no declivity has a great extension. Such is the condition of the Po, in Lombardy. The horizontal line of low-water of the Adriatic, when produced, cuts the bed of this river between Stellata and Lagoscuro*, which is a distance of 60 miles from the mouth. In the Primaro this horizontal rests about eight inches above the bed of the river, at a distance of 16 miles from the mouth.† In the Tiber the low water of the Mediterranean intersects the bed at the distance of 15 miles from the mouth.‡ But, on the contrary, in other smaller rivers this extension is less, as it has been said. Thus, in the Ronco and the Montone the low water of the Adriatic cuts the bed at a distance of about 3½ miles. In the Savio the distance is 3 miles, and in the Lamone 3 and 3-5ths. All this is fact, except some uncertainty in the intervals assigned, which cannot be defined with geometrical precision.

* Manfredi, Annotazioni al Guglielmini.

† Fresi.

‡ Zanotti.

But, after all, in the channels which have some horizontal part, remarkable in large rivers, must we consider so many trunks separately, or as if they only formed with the rest of a river having a declining bed, one individual system? The observations, already made, at the most, convince us that in the last trunks above the mouths of turbid rivers such causes are combined, proper and peculiar to those circumstances, as give sufficient motion and force to the water to scour the bed and keep it free from deposits, without producing in the bottom, for an extended space, the declivity which by the same body of water, and the transport of the same matters, is met with in the trunks immediately above. If then we do not depart from nature, which forms such channels in turbid rivers, almost additions and accidents in channels with inclining beds, but never solitary and proper to an internal system of turbid current waters, the theory which we have about horizontal beds, when we treat of turbid rivers, ought, if I am not deceived, to be rectified and adapted to other principles. How is it possible to adapt the notions which are in general taught concerning horizontal channels and their economy to the conditions of turbid rivers? Nature, at least, has not an example but in the condition of a single trunk, above the real or equivalent mouth, that is to say, always joined to the declining beds, or in similar circumstances.

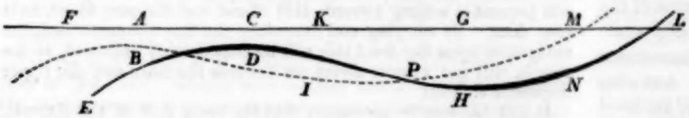
VI. Having thus assigned a proper importance to the condition of the almost horizontal beds in turbid rivers, and having brought together the subjects, which it is not possible to separate, it is very easy to trace back the effect upon the superior trunks of the elongation of the lines into the sea, which is the subject of this memoir. The mystery (§ IV.), which in such a research was by necessity induced, may be removed, by investigating minutely how such prolongations act upon the superior trunks, without altering the trunk between them and the mouth, considering this trunk not as unconnected, but as a pure accident of the declining bed of the river; and the question will then be reduced to a knowledge of the results, and the establishment of principles.

"What are the alterations and modifications produced in the almost horizontal trunk of a turbid river, which extends its line into the sea? by what means does it cause the advance of the declining beds in the superior trunks?" Although I am not capable of fully treating the subject, so as to present it free from every objection, which is not easy in a physical question so obscure, it will be sufficient to have been the first to have attempted this task, and to have tried, at least, to explain the subject in such a manner that others may, by new observations and new efforts, apply themselves to the completion of the theory.

VII. I do not believe that I can better advance my researches than by following the train of the observations made at the mouth of the Adige, and after following the phenomena observed in one part, explore the work of nature in the rest of the trunk. The following propositions will gradually open our way, and by a consideration of them, the discussion will be shortened and be better brought into order.

Prop. 1. "The elongation of the line of a turbid river into the sea is occasioned by the gradual filling up with detritus the concavity, or more advanced part of the bed, F C D E (fig. 2.), so that an elevation is produced where there was first a hollow, for this

concavity serves as the receptacle of the matters transported by the river, and a new mouth is formed with the least depth which is necessary for the discharge, under all conditions, of the waters of the river."



The experiments on the Adige, mentioned at the beginning of these observations, evidently show that this is the result. All this work goes on continually in that almost lake which the river forms in mixing its waters with the sea; and the same happens in all rivers which can keep open their discharge, as is proved by daily experience.

Prop. 2. By this reproduction of a new mouth, AB (fig. 2), an excavation in the trunk immediately above follows, by which the elevation or former mouth C D, is converted into a concavity.

This is also fully proved by the experiments made on the Adige. By the gradual accumulation of gravel and mud at the new rising mouth, and still more at the sides where the current is stronger, the waters immediately above are encompassed by their own alluvions, so that, having no more liberty to spread as before, and being at the same time raised to a greater height, they begin to excavate the bed, and to cut down the bank, as we have seen in our inquiries.

Prop. 3. The least depth of the mouth being advanced into the sea to AB (fig. 2), the acclivity of the bed, H D, also advances, and the greatest depth, G H, changes its situation, by which the superior bed remains depressed beneath the horizontal of the low tide of the sea, F L.

This proposition is the necessary consequence of the preceding, for having observed that the transposition of the higher portion of the bed at AB is followed by an excavation in the contiguous superior trunk, it is evident that the acclivity must advance and be reproduced, as in I B. Then, the river not having received any alteration by an increase or diminution of water, as is supposed, that is to say, the system of the river remaining constant, and being obliged in consequence to ascend with the same body of water the new acclivity, and to compose itself as before, it is also necessary that the point, H, where the ascent begins, that is to say, at the greatest depth, G H, under the horizontal of low tide, should move forward as into I K, and approach the advanced entrance of the river.

Prop. 4. From this it is evident that there is a reproduction of the former conditions in the lower trunk, after the advance of the mouth into the sea, and one may conclude, not without great reason, that the river, from B towards M, tends effectively to re-establish itself in a curve, BIPM, similar to, or the same as, that in the first bed, D P H L.

For such is the true and acting cause by which the deepened bed is maintained in the last trunk of a turbid river, with little or no declivity under the horizontal line of the low tide of the sea: as all engineers agree, the liberty of course which is acquired by the waters of the river, compels them at all times to spread themselves with the surface of the sea. In consequence of this the surface of a river, at some distance from its mouth, is lowered, the bottom narrows itself, and its discharge is disposed, as if in anticipation, to blend with the surface waters of the sea. And this distance will increase with the height from which the waters of the river fall, that is to say, in proportion to the height of the surface of the river, in its different states. Consequently where the rivers, in the last trunk, begin sensibly in high tides to lower their beds, the velocity also begins to increase, and the power to excavate the bed, which does not take place higher up, where this velocity is not produced, but it increases as the waters become rapid in approaching the mouth. The highest surface of rivers begins to fall at the point where the horizontal of the low tide cuts the bed, that is, towards the point L (fig. 2), as the observations made by Zanotti, on the Po of Lombardy, and on the Tiber, seem to prove. But, if this principle be established, it is easy to prove, that after the prolongation of the mouth into the sea, the river itself must advance. Let this point be at D, (fig. 3), and let DB represent the falling of the tide, the

mouth being at B; let us then draw DC parallel to the horizontal of the sea ABE, and from the point A, AC, parallel to BD. As the quantity of water is the same before and after the prolongation, if the river will not arrange its fall precisely in the line AC, parallel and equal to BD, there must be a small inclination from AC, there being no reason why the same body of water should not recompose the new falling of its surface nearly in the same state and condition as at first, in order to acquire in the corresponding parts the same degree of velocity, and spread itself on the surface of the sea at A. Having then taken a point, as F, in the horizontal DC, very near to C, and having drawn FA, if not CA, to represent the new falling, F is the point where after the advancement of the mouth in A the high surface of the river begins to fall. In fact, daily experience shows us that the new fall of the surface, as FA, after the prolongation of the line into the sea, induces the necessity of raising the banks in the last trunk, the surface of the high water rising higher than before.* Hence, then, we may consider as established that the position of the cause which, as we have said, acts by itself in keeping the bed in the last trunk with little or no declivity, when the mouth changes place, also changes, and of necessity takes its beginning lower. But if with this cause the reciprocal motion of the sea is combined, if not by itself, at least as an occasional cause, especially from the point where the river is altered by the flowing tide, the bottom of the bed must be rendered less declining, an effect which is not produced upon the superior parts, as many eminent men have observed†, and as it is reasonable to believe; nor will it be difficult to demonstrate, that the prolongation of the lines is extended at that point of the bed where such alteration on account of the sea terminates, and this assists the principal cause in making an alliance with the new bed. And in the first place, there can be no doubt that in the flowing of the tide, the river leans against a high surface of water, and in consequence elevates its surface to acquire the necessary velocity for the discharge of its own waters; and then, in the ebb tide, as its body of water is higher, it runs with greater velocity than it would have done if the sea had not raised it, and consequently with a greater force, to keep the earthy matter agitated and incorporated.

There is, then, some reason to believe, that from the point where

* Manfredi, Annotazioni al Guglielmini. Grandi.

† Guglielmini, Nat. de' Fiumi, cap. 8; Manfredi, Annotazioni al medesimo coroll.; Frisi de' Fiumi e de' Torrenti, cap. 7.

this check begins, the descent must increase more and more, and the cause adopted at the beginning becomes energetic, always diminishing the declivity of the bed the nearer it approaches the mouth. But, from the prolongation of the lines of rivers, the retirement of the sea is never disjoined, although it is not perceptible till after some time; this happens under the eyes of every one, and is demonstrated by the discharge of the rivers which fall into our seas. And after this recession of the sea it is evident, that the effect of the flood tide, which, in a river of determined system, must spread to a certain distance, can no more extend to the former place; hence, the point where the river began to be moved, before the prolongation of the line, by the action of the sea, advances and accompanies the removal of the mouth. But it is also seen, that at the point where it begins to incline towards the mouths, the high tide itself passes over by the protraction of the line. Then, also, the point, where the inclination of the body of water is combined, advancing towards the mouth, in the manner already stated, the action of the sea begins to be more active in reducing the declivity of the river. If then on one side, namely, towards the mouths, the forces become more active, and better able to excavate the bed than they were before the prolongation of the line, and on the other side they remove and cease to act, it is clear that an excavation will be produced, as PIB (fig. 2), on that side where the forces ought to increase, and an elevation of the bed, as PML, on the opposite side, where the force is diminished. And if the river could in this new disposition of its bed re-arrange itself, it is certain, that employing the same means in the formation of the new trunk which co-operated in the formation of the preceding, changed only in situation, it would produce the new bed, after the prolongation, placed in a similar manner to the preceding. But the mouth being always subject to changes from new protractions of the line, and to the effects which always accompany these changes, and consequently being unable to re-establish with great accuracy the bed of the river, we may at least conclude, with good reason, that the river tends effectively to re-establish its new bed in a position similar to the preceding bed, PDHL, which was the subject of this proposition.

(To be continued.)

A SERIES OF REPORTS ADDRESSED TO THE CORPORATION OF BOSTON, ON THE IMPROVEMENT OF BOSTON HARBOUR.

(Continued from p. 302.)

REPORTS BY MR. LEWIN.

Boston, Sept. 19th, 1842.

Gentlemen,

I beg to state that the works in Boston Haven have now been proceeded with by the contractor, Mr. Beazley, with considerable success, and that the greater part of the fascine or kidwork on the eastern side has been laid, and a large quantity of the excavation of Corporation Marsh has been executed, so that part of the beneficial effects that were anticipated have been realized, by making a better, and more direct, and deeper channel for the navigation, and which has equally improved the outfall drainage of the several districts above the new works; and as the works have now proceeded far enough to judge of the effect of the channel upon the works on the western side, and the necessity of supporting the same, as the channel formed itself as I mentioned in my Report to you, Gentlemen, of the 10th of May, 1841.

In accordance therewith, I beg to state that it will be necessary to continue a line of fascine work, backed with clay, on the western side, from the north end of the kidwork formerly laid down opposite Hill Marsh, and to continue the same to near the north end of the excavation of the new cut through Corporation Marsh. The above line will require to be kept eastward of the line formerly kidded, so as to prevent as much as possible the accumulation of warp that now takes place in the low-water channel at this part, and by continuing the line as recommended, the flood tide will have a more direct run into the new channel at Corporation Marsh, and which will prevent it setting towards Hill Marsh and Slippery Gowt, as it now does. By carrying and extending the line recommended, the navigation upon the flood tide will be considerably improved, as the vessels will get a more direct set towards the town and the upper improved channel.

It will likewise be necessary, that the lower part of the channel, which consists of clay beyond the line of the present contract, and which will not scour away, should be removed by artificial means, so as to give the flood and ebb tides a fair way from the new channel, otherwise the clay will form a bar to the entrance at Corporation Marsh. These works can be executed much cheaper and better now than you will be able to do them at any time hereafter, as the contractor has a sufficient quantity of clay to back the kids with, which he must excavate under his present contract, though he could not be bound to boat it to the new work; and I believe he has a sufficient quantity of kids for the formation of the line in question; so that, if terms can be arranged, the work may be proceeded with immediately. To carry these works into execution on the western side, and remove some clay from the channel beyond the present line, will cost £1743, or thereabouts, and to continue the new work on the west side, along the whole of the front of the present old kidwork, opposite Toft Jetty Point, will cost an addition of about £450, making a total sum of £2193.

I beg further to state, that it will be better to raise the pier at Rush Point, and extend the same with kids and clay, in order that the low-water channel may have as little opportunity as possible of meandering out of its course, there being already a small accumulation of warp on the eastern side next the fascine work, opposite Pudding Pie Point, which is caused by the set from the Rush Point: indeed, it will add very materially to the perfection of the low-water channel, if the fascine work is joined on the western side, between Rush Point and the part above recommended to be extended, to the north end of Corporation Marsh.

In executing the works on the western side, it will be necessary to preserve an outfall for the drainage by the Slippery Gowt.

I remain, Gentlemen,
Your most humble Servant,
WILLIAM LEWIN.

Boston, July 22nd, 1843.

Sir,

Agreeably to your directions I beg leave to state, that I have fully considered the subject you refer to, and I am sure the propriety of your suggestions must be satisfactory to all parties who are anxious for an improvement being made in the outfalls of the rivers Witham and Welland, which unite their two bodies of water together, and principally pass through what is called the North Channel into Clay Hole, which lies in a N.W. direction from Clay Hole, and is generally used by vessels that trade either to Boston or Spalding; but, in consequence of the channel being obstructed by what are called the Hummocks, vessels are obliged to lie to until there is a sufficient draught over these tops or hills of clay, to enable them to sail over unobstructed into the channels or outfalls of the Witham or the Welland.

These hummocks consist of small hills of indurated, adhesive clay, between which the ebb and flood tide channels meander, until there is sufficient water to cover them, and which form serious obstruction to the free discharge of the waters from the rivers Witham and Welland, tending to hold up the sand, and increase the obstacles above the same.

To remove or lessen these obstructions, has long been the desire of all parties who navigate in these channels, and which may be done, as you suggest, by the assistance of the steam dredging boat at present employed by the contractor of the works now carrying on in Boston. Of course, the cost of this improvement would altogether depend upon the width and depth of the channel made, or, more properly speaking, of the quantity of clay removed, as I fully expect that the silt will scour away as soon as the clay dams are lowered; and I am of opinion, that the North Channel may be greatly improved, and the whole of the hummocks removed, for the sum of £2300, and which improvement would essentially benefit,

not only the navigation of the rivers Witham and Welland, but all the lowlands that drain thereby, as is always the case in an improved outfall.

I remain, Sir, Your most humble Servant,
WILLIAM LEWIN.

The Corporation having determined to improve the haven according to the suggestions of Mr. Lewin, contained in his Report of the 10th of May, 1841, tenders were invited for the works, and that of Mr. Beasley accepted: the works to be executed according to the following Specification of Mr. Lewin, and under his superintendence.

SPECIFICATION

Of the work proposed to be executed by the Corporation of Boston, on the Eastern Side of the Boston Haven, commencing at the East Wing Wall of Maud Foster's Sluice, and terminating at the Western Extremity of Corporation Marsh, adjoining Toft Marsh Bank.

The contractors are to undertake to remove the kids, stakes, and binders, now belonging to the Corporation, from the situations where they are now deposited, and to remove them, and lay them in such parts of the line of embankment as may be pointed out upon the spot. All other kids, stakes, and binders that may be required, will be furnished by the Harbour Trust, and to be carted as near the works as the public roads will allow, and to be removed from thence by the contractors to the work; or the contractors are to take the present kids, stakes, and binders at the price paid by the Harbour Trust for the same, and to furnish all other kids, stakes, and binders necessary to complete the works.

The contractors are to commence the fascine work at the eastern wing wall of the Maud Foster's Sluice, and to lay the ground-work of the fascine facing in a a curved plan struck from a radius of 240 feet, as shall be directed, and the line from thence is to be continued until it joins a curve that is to be struck from a centre on the west side, having a radius of 1350 feet, sweeping round Church Point towards Pudding Pie Point, and the line from thence by Pudding Pie Point is to be continued in a line as directed, until it joins Toft Marsh Bank.

The contractors are to excavate and embed in the present sand, at the required level, a course of kids to form the ground surface for the fascine work, the front course to be embedded one foot below low-water mark, and to be sunk at the back 2 feet 6 inches below the front, and to be 13 feet wide at the base, and in the parts where the line of fascines cross or follow the line of the channel in deeper water, they are to be well bedded in the line, and to the depth required, and each course is to be covered with 6 inches of good clay, well trodden and beat solid upon the kids; and in laying each course of kids, care is to be taken that they well bond over each other, and as they approach the required height, the courses of kids are to be gradually reduced in width, by using kids of a different length, until they terminate at a width of 9 feet at the top.

The depth of the kidwork must be regulated according to the depth of the water in the channels that the lines pass over, but the general line must be executed to a parallel height of five feet in front above low water at spring tides, in addition to the kidwork required below; and at the deeper parts of the channel, the kids laid in the curved parts of the line, near Maud Foster's Sluice, are to be further secured by small fir poles from 16 to 18 feet long, well secured to the kids, with their largest ends embedded in the sand and silt at the back, and placed not more than 5 feet apart, and at such parts as require it, they are to be wattled and secured to the kidwork, and staked down to the same, and when the first three courses of kids have been well laid down and embedded in the sand, they are to be further secured by stakes put in every third kid in front, and well driven down with the top of the stake level with the top of the kid.

In the execution of the work, the parts exposed to a heavy inrun from the ebb or flood tides are to be further secured by stone thrown in front, to the extent of 1200 tons, which the contractors are to provide when required, and which is to be deposited at such parts as directed: the contractors will also have to provide six old flat-bottomed catches or boats not less than 50 feet long, which they will be required to fix in the parts pointed out in the execution of the work, and to excavate and load the same with clay, and properly secure them in the required line with piles, &c.

The top course of kids is to be well secured to the other kids by stakes, 6 feet long, driven into the kids at about 1 foot 6 inches from the front, and well wattled and bound together by binders, and the surface of kids to be well covered with a layer of tough clay. The whole of the clay, &c. required to back up and bed the kids is to be brought from Corporation Marsh.

At the same time that the fascine work is proceeding with from Maud Foster's Sluice, the contractors are to proceed with the cutting away of Corporation Marsh Point; the contractors are to undertake to cut away the Point, in the line of a nicking which will be made upon the Marsh, showing the part proposed to be adopted as the bottom of the low-water channel, having slopes of 3 feet horizontal to 1 foot perpendicular to the same, and the bottom is to be 160 feet wide.

The bottom of the cut through the marsh is to be excavated to a depth of 5 feet below the present low water in the channels, or 3 feet 9 inches above the level of Hobhole Sluice cill: the whole of the best of the clay excavated is to be removed and laid between the courses of kids as the work is executing, and all the useless earth is to be carted or wheeled upon the marsh adjoining the cut, care being taken that that the earth is not laid nearer than 30 feet of the prick of the cutting, with slopes on the sea side to the bank of earth, of not less than 4 feet horizontal to 1 foot perpendicular, and as the excavation proceeds, lines of fascines, as before described, are to be laid from Corporation Marsh, in a line to join the kidwork from Pudding Pie Point, which is to be well backed up with the clay excavated from the marsh, precaution being used that the kid work is laid in a line with the slope of the new cutting.

The top of the kids along the whole line, when laid to the required height, is to be covered with the best blue clay, dug from Corporation Marsh, having hay and straw well chopped in and mixed in the clay, and the clay to be laid not less than nine inches deep over the whole surface of the kids.

When the whole of the kid work has become consolidated, the corporation is to provide for the whole line of the fascine work, some thin rubble stone, not less than six inches thick and three feet wide, and the contractors are to embed the same in the clay, and to lay them as close to the line of stakes and binders as the work will admit of, provided the same should be found necessary.

The contractors are to make and maintain all dams, stanks, and cradges necessary to keep out the water, and remove the same when done with, and to ease, pump, or remove the water when necessary for their work.

The contractors are to undertake to furnish all kids, stakes, and binders, and to take those provided by the Harbour Trust, making a proper allowance for the same, and to furnish all stone, old boats, poles, hay, straw, and every other material required for the same, as before described; and to furnish all labour, boats, horses, carts, machinery, and everything else necessary to execute the work; and to be responsible for all accidents, and to keep the same perfect for twelve months after completing the contract; and to undertake to execute the whole in a good and workmanlike manner, to the satisfaction of the engineer or surveyor appointed to superintend the same.

The contractors to send in a tender, in a lump sum, for completing the whole of the work, and the harbour trustees to have power to make such additions to the work, or deductions from the same, as they shall think proper, without in any case invalidating the contract, proper allowance being made for any addition or deduction from the same, as the case may be.

The contractors are to execute work, or furnish and fix materials in the work, to the amount in value of £300, previous to an advance of money being made, and the contractors are to furnish the surveyor with a detail of prices formed according to the principle of the contract, to enable him to judge of the propriety of the advance of money applied for on each application.

The contractors are to give notice in writing to the surveyor one week before they require an advance of money on account of work performed, which amount shall be ascertained, and the contractors shall be paid at the rate of £80 per cent. for the same: the remaining £20 per cent. is to be left in the hands of the trustees as a security for the due performance of the contract, and which reserve is not to be paid until the work is completely finished. The contractors will be required to name their securities at the time they tender for the work, or otherwise their proposals will not be attended to.

Should it appear to the surveyor during the execution of any part of the contract, that the contractors are not executing their work agreeably to the contract, or are not proceeding with sufficient despatch, written notice shall be given to them of such deficiencies; and in case they do not immediately remedy the same, the surveyor shall have power to stop the work until the contractors shall satisfactorily show that they possess the power of remedying, and will remedy the defects or insufficiencies complained of; and should they fail in performing the same, the trustees or their surveyor shall have full power and be at liberty to take the work out of their hands, and employ other persons to complete the same, and any additional expense that may arise, from any cause whatever, beyond the sum contracted for, is to be made good by the contractors or their securities.

The contractors are to undertake to execute the whole, on or before

If any dispute or difference of opinion shall arise as to any matter, clause, or thing connected with these works, or upon the mode and manner of executing the work, or of the value of any work done or left undone, or anything else connected with the work in question, the same shall be decided by the principal engineer appointed by the corporation of Boston; and this clause is to be considered as binding upon both parties without reference to any other person or persons whatever.

WILLIAM LEWIN,
CIVIL ENGINEER.

Boston, 4th June, 1841.

The works described in the preceding Specification are now drawing towards completion, and have so fully answered the expectations of all parties connected with the town and harbour, as to induce further improvements on the opposite side of the river, as recommended by Mr. Lewin in his Report dated Sept. 19th, 1842.

We have no doubt, also, that another most desirable object will be effected,—the removal of the clay hills, which obstruct the outfalls and entrances of the harbours of Boston and the neighbouring seaport of Spalding, as mentioned in the Reports dated May 10th, 1841, and July 22nd, 1843.

This economical method of confining the channels of rivers, and, by so doing, straightening, deepening, and consequently improving them, by mere extended lines of fascines, formed of thorn faggots mixed and bedded with clay, as detailed in the above specification, has only within the last few years been advantageously introduced, in a few of the harbours of Great Britain. In that of Boston it has had some severe trials on several occasions, by both the tides and freshes, the former having entered the harbour with a flood wave several feet in height, and some idea of the strength, force, and rapidity of the freshes may be formed from a knowledge of the large extent of lowland which is drained through this harbour.

MR. BROOKS ON THE CAUSE OF BARS AT THE MOUTHS OF TIDAL HARBOURS.

TO THE EDITOR.

SIR,

YOUR correspondent, Mr. Prichard, must surely rely upon my exposé of his plagiarisms and piracies not being read, or he would not attempt to insult your readers by his special pleading.—I do not however think him worth further trouble on my part. Your readers will merely say, of his awkward attempts to get out of the awkward dilemma in which he has placed himself—

"A sieve of shelter maketh showe,
But every storm doth through it go."

His four-column letter does but heap upon him further shame, that he has not sufficient moral courage to apologise for his conduct.

Dropping the subject of Mr. Prichard's piracies, I will but advert to his last letter, to show how little acquaintance he has with the subject on which he treats, notwithstanding "*that in these days great strides and progress in advance have been made in science.*" Of course Mr. Prichard, by the above, means the short cuts by which he tries to obtain credit for information.

Reverting to Mr. Prichard's letter, in page 308 of your September Journal, I find the following:—"But does Mr. Brooks, on his principle or theory, explain such cases as that of Newhaven Harbour, on the east of Shoreham? That this harbour has a very *gentle slope and inclination,* will be seen by reference to what the Commissioners appointed to survey the harbours on the south-eastern coast, have stated respecting it; they say,—The bar is left dry at low-water spring tides, but within the piers there is about two feet water at such times, and this depth continues uniform for a mile up channel."

Now, my reply is, that the above extract from the report gives no evidence that the features of the Ouse (Newhaven) make the latter an example, controverting my theory; but the evidence by the levels of Smeaton, (see Vol. I., page 340,) is conclusive, that this river affords an example corroborating fully my theory on the cause of bars. *Thus, in lieu of the lower reaches of the river having, according to Mr. Prichard's version, "a very gentle slope and inclination," the reverse is the case.*

The following is from Mr. Smeaton's report:—"It was observable, during my stay, (the tides being then in a mean state, betwixt spring and neap, and the river pretty full of water,) that the tides were scarcely sensible at Lewes Bridge, and but a few inches rise and fall at the mouth of the river Glynd; while at the Sheep Wash, above Piddinghoe, the tides rose and fell 5 feet, and not above half a mile below, at the head of the Broad Salts, the rise and fall was near 8 feet; the greatest part of the whole fall lying betwixt the last-mentioned place and White Wall, a space not above two and a half miles, according to the course of the river, and which includes at least seven-eighths of the whole fall from Lewes Bridge to the head of the Broad Salts, which is a length of near 7 miles. This great declivity in the river, from White Wall to the Broad Salts, is doubtless owing to a series of shoals lying in that space, the principal of which is Piddinghoe, which alone has a fall of 3 feet."

Mr. Smeaton proceeds to show, that from the Broad Salts to Sleepers Pool the declivity is more gentle, but from Sleepers Pool, near the mouth of the harbour, where the ships lie, there is "a fall of 6½ feet to the low-water mark at sea, which at spring tides is greater."

From the above levels we find that from Lewes Bridge to White Wall, a distance of 4½ miles, the whole fall is only 12 inches. From White Wall to the Broad Salts, a course of 2½ miles, the fall is 7 feet, or 2 feet 9 inches and six-tenths per mile; from the Broad Salts to Sleepers Pool, above the mouth of the harbour, the fall is 2½ feet or 12 inches per mile; and that the remaining short distance from Sleepers Pool there is the great fall of 6½ feet, the level of low water of a 17-feet tide at sea; neap tides, rising from 14 to 15 feet, and spring tides from 19 to 20 feet, giving an average of 17 feet.

Piddinghoe, where the rise of tide is only 5 feet, is about 3½ miles from the sea, and the flow there, when compared with only a 17-feet rise of tide at sea, gives us a fall of 12 feet in 3½ miles, or rather more than 41 inches per mile; and we have already seen, that in the upper tidal course of the river, or from Lewes to White Wall, the fall is only 12 inches in 4½ miles, or less than 2 inches and six-tenths per mile.

I have now shown, from good authority, that Mr. Prichard was completely ignorant of Newhaven Harbour,—the river Ouse, when he quoted it as an example of a bar harbour having a very gentle slope and inclination, and therefore opposed to my theory, because that river has a bar.

From the above account of Newhaven Harbour it appears that there must be a very great extension of the duration of the period of the ebb over that of the flood; and that even at the short distance of 3½ miles from the mouth of the harbour the tidal influence cannot be felt until it is two-thirds flood at sea; or, allowing for the inclination or head necessary to turn back the ebb, not until nearly three-quarters flood.

Mr. Prichard next quotes Little Hampton Harbour, on the west of Shoreham, which, he says "has a bed agreeable in every respect to the following language of Mr. Brooks, in explaining his views on 'rivers free from bars, (see page 19 of his book,) viz. a long line of

navigable channel exists, with an extremely gentle fall or slope of its surface at low water; the river is, in this case, in a proper train, its longitudinal section presenting a succession of inclined planes, becoming more and more gentle as they approach the ocean.'" On the above Mr. Prichard has the following observation:—"Now the fall at Little Hampton, for a great distance, is only 7 inches per mile, and yet it is encumbered with a bar of great magnitude." Mr. Prichard continues:—"How does Mr. Brooks' theory stand in connection with the harbour?" My reply is easily given, viz., that the example quoted is one *corroborating its soundness;* and if Mr. Prichard had not a very slight acquaintance with the subject, he would not have committed himself by calling a slope of 7 inches per mile "an extremely gentle fall." I know it to be a very great fall for a tidal river, though it may be very gentle for a railway gradient; and the fall of the Arun is only small when compared with rivers whose beds are nearly choked up with shoals or sand-banks, forming a series of rapids or natural weirs.

The Thames, Seine, Loire, Gironde, Shannon, and other noble rivers, would be very different from what they are, had they but half the "very gentle inclination," so called by Mr. Prichard. With such a fall of the low-water surface, the tidal influence would but in few rivers be felt to extend more than 20 miles, even at spring tides.

Mr. Prichard's very gentle inclination exceeds by above 2 inches per mile the present reduced fall of the Tees for a length of 12 miles from the bar. It is also more than 3 inches per mile greater than that of the Tyne in its lower reaches. These are however rivers with bars, but not with such bad bars as are to be found at the mouths of rivers with greater declinations. The Tyne and Tees have from 8 to 9 feet water over their bars at low-water spring tides.

Between these two rivers is that of the Wear, which bears stronger features of a bar-river than those just observed. In the Wear, which has from 2 to 3 feet on its bar at low-water spring tides, the slope at low water, or rise from the mouth of the river, is 5 feet in the first 3 miles, or at the rate of 20 inches per mile; between the third and fifth mile the rise is 19 inches per mile, while between the fifth and seventh mile the rise is only 1½ per mile; and between the seventh and ninth mile the rise is 13 inches, or 6½ inches per mile. At this distance of 9 miles from the sea the tidal rise is 5 feet, or 9 feet 6 inches less than at the mouth of the river. The average fall is therefore above 12 inches per mile; but we have already seen that in this bar-river the declination "is greater in the lower than in the upper reaches;" and such I doubt not to be also the case in Little Hampton Harbour, or the river Arun, notwithstanding its general average may be, as stated by Mr. Prichard, 7 inches per mile. Possibly some of your readers may favour me with this information.

A reference to Mr. Prichard's reports and plans, shows that he has not lost sight of the information obtained from my work, which, doubtless, opened his eyes to the features of Shoreham Harbour, and caused him to recommend to the Commissioners the removal of the shoals, to lower the low-water surface; or which caused him to remark to these gentlemen, that "The great rise of the bed of the river, from its entrance to the railway quay, is a *great* auxiliary to the formation of the bar," which, I before remarked, was taken from page 69 of my work,—"Seeing that the existence of bars is to be attributed to the too great declivity of its low-water surface."

In Mr. Prichard's letter in your October Journal, the word "*great*" before "auxiliary" is dropped; but the Commissioners of the harbour may rest assured that Mr. Prichard's "faith" reposes more upon this acting upon my theory than upon the bar of Shoreham Harbour being improved by his shingle trap, zig-zag, terminus of his concave western pier.

The zig-zag finish is certainly Mr. Prichard's idea, but the concave pier to the current is not his own. He might have borrowed the plan elsewhere; but it was, at all events, much urged in my work, when speaking of the pier at Swinemunde, and in another part, when treating of the Adour; and surely Mr. Prichard might have seen it when under the same mesmeric influence, or otherwise, by which he has, so unknowingly to himself, transferred so many paragraphs from my work. He has not quoted them from any other author, for I defy him to bring proof of it from any of the authors on the motion of water, whose works Mr. P. says he has very carefully studied "in the original." I feel sure that *his* reading will not suffice to add me to the number of plagiarists.

The following is the extract from my work:—"If the pier at the mouth of the Adour, which is next to the side from which the sand (or shingle) is brought by the surf, had been made convex to the quarter from whence the impulse is derived, or that windward pier had been made concave to the action of the current, the latter, seeking always to escape at a tangent to a curve, would prevent the possibility of any sand lodging in the channel alongside its face. This latter arrangement would guarantee that no LODGEMENT should ever take place within the piers; the river-bar would still exist outside the pier ends, and its removal or amelioration will form the subject of succeeding pages."

I shall now, Mr. Editor, refer to your observations in page 295, in your essay on bar harbours, in which is the following:—"But all bars, considered in reference to their composition, may be divided into two classes, sedimentary and erratic. The want of a proper distinction between these two kinds of bars has been the cause of great confusion in the minds of those who have written in English on the subject, and has originated the promulgation of opinions which, though in reference to one class, they have been near the truth, have been in regard to the other equally erroneous. Mr. Brooks, a modern writer on this subject, has, for want of this distinction, exposed himself and his theory to many objections."

Now, Mr. Editor, I do not think that I am liable to the charge of confusion on the subject, and it shall be my task to show to you that *I* have not confounded *bars* with *banks* caused by a temporary check to, or shelter from the impulse of prevailing gales, by which these banks, at times, so largely accumulate, and by which the condition of a port is rendered so much inferior to what it would otherwise be, were the material moved by the surf, or thrown by it into the entrance of a harbour, more easy of removal during the duration of the ebb. In continuation of my remarks on the Adour, which is a river obstructed by shingle at its mouth, is the following:—

"The example which has been adduced by Col. Emy, of the bar of the Adour being found to increase in extent during tempestuous weather, and to *diminish* during long calms, shows that the *deposit* is really due to the onward or progressive motion of the sand (shingle) along the shore, which, being *checked* by the piers or jetties between which the Adour is conducted, lodges under their shelter, and thus is the bank of sand augmented during gales of wind, until it is reduced by the out-pourings of the river. *The increase of sand (shingle) is such as would occur between the piers of any harbour unprovided with backwater.*" And further, "There is then at the mouth of the Adour a *bar* which can never be removed while the river is in its present state, and there is also an occasional *lodgement of sand* (shingle) which is capable of being removed by the backwater during calm or moderate weather,"—by which I clearly mean, that there is a *bar*, which is due to certain natural features of the river, in accordance with my theory on the cause of the existence of bars, and there is also a *bank* or *lodgement* of shingle, which is due to the check to the onward impulse of the gales, which make the shingle or sand travel along the coast; or what you, Mr. Editor, call an "*erratic* bar." The manner in which the shingle travels along the south-eastern coast is no discovery of Mr. Prichard's; no new light has been thrown on the subject by him. Reports fully describing it have long since been published, from those by Smeaton down to the more recent ones by Mr. Palmer, and Col. Williams, of the Royal Engineers—in both of which the subject is clearly discussed. Nothing new has come from Mr. Prichard except his zig-zag termination, which would soon change its outline by the accumulation of shingle, and would only cause a broader bank before the harbour's mouth than if it were dispensed with.

You have, Mr. Editor, in allusion to my theory, drawn a distinction between the eligibility of its application to some rivers and not to others, such as those with shingle bars. Now, Sir, if my theory on the cause of the formation of bars, or rather my remedy for their amelioration, be duly considered, I doubt not it will be found applicable to one case as well as to the other.

My practice provides for the diminution of the duration of the period of confliction of the ebb and flood currents, and for the increase of the power of the backwater. Thus, in round numbers, when we find at a bar river, or say at a very short distance from its mouth, the duration of the *upward* current of the flood tide is 4 hours, and the duration of the ebb is 8 hours, it must be obvious to any thinking mind that the power of the ebb or backwater would be

very much increased, or it would run with greater velocity, if it were discharged in 6 hours in lieu of 8 hours.

Again, it must be also equally clear, that by the lowering of the bed, or inner bars, or shoals, the space which is now only filled up at low water *with pent up water*, will on every ebb be discharged, and on every flood be re-filled with tidal water, which, on the return of the ebb with the natural drainage or backwater, will exert its influence in maintaining good water in the channel and on the bar. Let us keep close to Mr. Prichard's examples, and take that of the Ouse (Newhaven). Here we are told, that the rise at sea is in spring tides from 19 to 20 feet, and in neaps from 14 to 15 feet; and during an average rise of 17 feet at sea, or at the period taken by Smeaton (between spring and neaps), there is a fall of 6½ feet in the lower reach of the river; and that at the short distance of 3½ miles from the sea, the rise of tide is only 5 feet, thus giving a fall in the low water surface of as much as 12 feet in that short distance of three miles and a half. It must, therefore, be three-quarters flood at sea before the current of the ebb can be turned back, or before the flood current can make its way at this place, Piddinghoe, which is only the short distance of 3½ miles from the sea—(be it remembered, that I am now reasoning solely upon the faith of the accuracy of Smeaton's levels).

Close to the mouth of the harbour we find the rapid fall of the low water surface 6½ feet at medium tides, and "much more at spring tides." Great then must be the nature of the obstruction to the flood current; long must be the period of the confliction of the two currents; and abundant the consequent deposit of all material, whether sand or shingle, brought in by the mere tidal indraught, or washed in by the surf or wave when those gales prevail which make the shingle travel along the coast.

Now, owing to the adoption of my theory, or my means of ameliorating the condition of bar rivers, a vastly increased tidal receptacle must be the result, the contents of which would be discharged with much greater rapidity than in the previous state of the river, and consequently it is but reasonable to believe that its good effects would be felt by the reduction of the bar or shingle bank.

In conclusion, I beg to remind Mr. Prichard of his error in stating that my work on rivers is not provided with examples. *It is full of them.* He will find, also, that I have given examples, showing the error which he has adopted of partly ascribing the existence of bars as owing to any peculiar direction of the lower reach of a river, or to the direction of its discharge. I allude particularly to the Tees, which has changed its course more than eight points of the compass since 1805. I have witnessed since 1831 its change of course from N.N.W. to N.E., and yet the bar was always there, with the same depth of water on it.*

If Mr. Prichard a second time make a tidal section, it will be more useful if, in lieu of his mode, he give the levels at different stations as taken simultaneously, or showing the precise section or profile of the tide at every time of observation. Reserving further remarks until another opportunity,

I am, Sir,
Your obedient Servant,
W. A. BROOKS.

Guildhall, Newcastle-on-Tyne,
October 7th, 1843.

* No argument has yet been advanced why the waters of a river should not be discharged into the sea at right angles to the shore? Mr. Barrett, of Norwich, is the author of a theory of an oblique discharge being necessary to get clear of bars; and yet, in planning piers at Lowestoffe and Dungeness, he actually provides for a rectangular discharge. Neither he nor his pupils tell us any reason why an oblique discharge is requisite, or why a river should travel crab-ways to sea—but Smeaton somewhere, in giving a plan for piers for a river, says, "they must be carried out in a direct line to sea, for I know no reason why another course should be preferred."

WESTMINSTER BRIDGE.

In a former number (page 133) we inserted Mr. Barry's Report on the Decoration of the New Houses of Parliament, addressed to His Royal Highness Prince Albert. In that Report Mr. Barry strongly urges the necessity of several local improvements, and especially that of reconstructing Westminster Bridge, the most incommodious and unsightly of all the great highways over the Thames. The opinions of this eminent architect were disputed by Messrs. Walker and Burges, the engineers at present employed in repairing and extending the bridge, in a report addressed to the Speaker of the House of Commons. Mr. Barry has replied to this in a letter to the same gentleman. These documents are in themselves exceedingly interesting and important, but will be examined with more interest when compared with the designs which we are now able to present to our readers.

Report of Messrs. Walker & Burges *on the alterations proposed in Westminster Bridge, addressed to the Speaker of the House of Commons.*

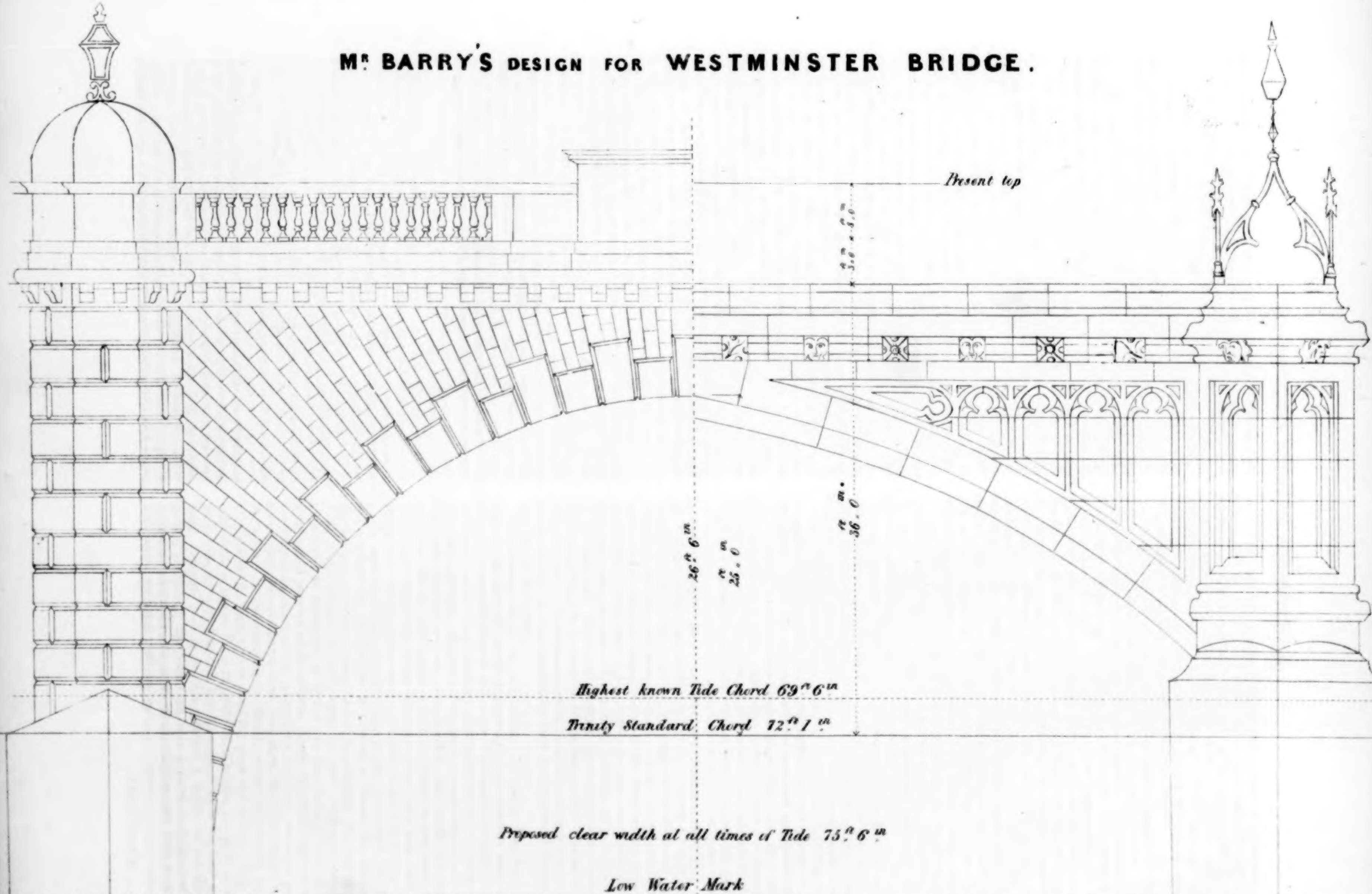
Sir,

As that portion of Mr. Barry's Report to His Royal Highness Prince Albert (on the decorations, additions, and local improvements connected with the new Houses of Parliament) which refers to Westminster bridge, may naturally lead to the opinion that our plans, made under the direction of the Bridge Commissioners, were confined to the repairing and extending of the foundations, for our superintendence of which he kindly compliments us; we consider it, therefore, a duty to prevent such a mistake, by stating, that the designs, estimates, and the contract with Mr. Cubitt, included the repair of every part of the bridge, the "removal of the present steep and dangerous acclivities, and the lowering of the parapet and road-way to the lowest possible level" that appeared at the time to be consistent with the safety of the present arches. The second contract with Mr. Cubitt, is for lengthening the piers, which are being carried to above high water level, to receive arches for widening the bridge twelve feet. It will then be of the same width as London-bridge. All, in fact, that we have done to Blackfriars-bridge is designed and contracted for to be done to this bridge, with the very important addition of the preparation for widening. The steepest part of Westminster-bridge road-way will, when the designs are executed, be as easy as that of Blackfriars-bridge. That which rises one in fourteen, will be reduced to one in twenty-four, and even this rise will be for only a limited length.

To secure the foundations, which were in danger of being undermined by the scour consequent on the removal of old London bridge, has been the first object. The supposed difficulty of doing so effectually, was increased by the opinion entertained by Labelye, the original engineer, and others since his time, that owing to quicksands, coffre-dams could not be applied; and the commissioners have been desirous of removing all doubt on this point, before proceeding with the spandrils, road-way, or parapet. Five out of the seven coffre-dams have been built; so far, we have been completely successful: and while the water was excluded, all the work which was required in repairing and lengthening the piers to above high water, has been done; seven out of the thirteen arches have also been repaired, as the coffre-dams gave facility for the scaffolding necessary for doing this. Thus far, therefore, our design proposed to, and approved by, the commissioners, corresponds with, and has anticipated Mr. Barry's; but the idea of taking down the present semi-circular, for the purpose of substituting pointed arches upon the same foundation, is not ours, and we beg to state, shortly, why we do not concur in the expediency of this proposal.

Mr. Barry's first argument for this change is, "that the pointed arch will enable the road to be lowered, by materially reducing the thickness of the crown of the arches, within what is considered necessary for arches of a circular form." Now, we consider that the whole thickness of the stone-work and covering of the present centre arch may be reduced to about seven feet, which is the same thickness as Mr. Barry's ribs, arch and covering, measured upon his section; so that, even supposing the principle he states, of the pointed arch requiring less thickness than the circular arch, to be correct, he obtains no reduction in thickness, and only lowers the road-way, by lowering the soffit of the arch. The generally approved theory of arches is, however, directly at variance with Mr. Barry's. In "Pratt's Mathematical Principles of Mechanical Philosophy,"—considered a standard work, and, as we are informed, a

Mr. BARRY'S DESIGN FOR WESTMINSTER BRIDGE.



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CENTRE ARCH

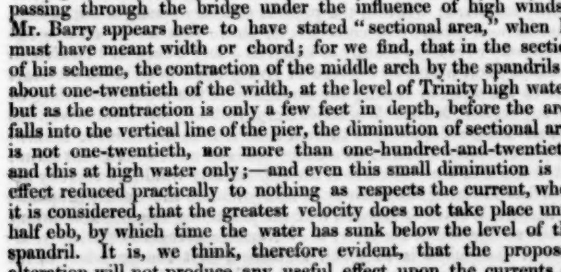
ONE HALF AS AT PRESENT

ONE HALF AS PROPOSED

Scale 10 Feet to an Inch.

text-book at Cambridge,—the theory is so clearly explained, that we give it in his own words:—"A pointed arch," he says, "must have a great pressure on its crown to prevent its falling, because it may be considered as consisting of two extreme portions of a very large circular arch brought together, so that the pressure on the crown must at least equal the pressure of the portion of the circular arch which is removed. Flying buttresses always have a great pressure upon their highest part. The pointed arch will sustain almost any weight on its crown, provided the lowest stones do not give way, and, consequently, the Gothic arch is stronger for lofty buildings than the circular; but the circular arch is far better adapted than the Gothic arch for bridges, since the pressure of weights passing over may act upon any part of the arch, not only on the crown." Mr. Whewell comes, in different words, to the same conclusion; and the same can be deduced from Attwood, though not so clearly expressed. These are no mean authorities; indeed, we do not know an exception in any author, British or foreign, to the opinion, that the pointed arch requires a greater thickness of material at the crown than the circular arch to keep it from rising; and if so, the substitution of the pointed arch should, in place of allowing a reduction, demand an addition to the least thickness required for the present arches. Add to theory, the experience of every modern engineer of this or other countries, as shown in their bridges of any considerable size: for we are not aware of any example of a pointed arch for a bridge of any magnitude in the works of Smeaton, Rennie, Telford, Perronet, or indeed of any other.

Mr. Barry's second argument for substituting the pointed arch is —"the elevation of its springing above the level of high water, by which the waterway of the bridge will be the same at all times of the tide, in place of being contracted by the present spandrils at high water, being nearly one-twentieth of its sectional area, occasioning currents, with a fall, and sometimes danger to craft in passing through the bridge under the influence of high winds." Mr. Barry appears here to have stated "sectional area," when he must have meant width or chord; for we find, that in the section of his scheme, the contraction of the middle arch by the spandrils is about one-twentieth of the width, at the level of Trinity high water; but as the contraction is only a few feet in depth, before the arch falls into the vertical line of the pier, the diminution of sectional area is not one-twentieth, nor more than one-hundred-and-twentieth, and this at high water only;—and even this small diminution is in effect reduced practically to nothing as respects the current, when it is considered, that the greatest velocity does not take place until half ebb, by which time the water has sunk below the level of the spandril. It is, we think, therefore evident, that the proposed alteration will not produce any useful effect upon the currents or the falls. When the bed of the river under the arches is lowered (which also is part of the contract), and the coffre-dams removed, the present current through the bridge will be materially lessened. Some practical good would be effected by the higher point of springing of the pointed arches, in giving more head room for craft near to the piers; and, as Westminster-bridge arches have less space for navigation than any of the four City bridges, any increase of accom-



modation is desirable; unfortunately, however, while an addition is thus made for one-fourth of the width of the arch near the springing, a portion is taken away from the height for the remaining three-fourths, nearest the crown, where it is of the highest importance; this diminution varies from eighteen inches to thirty inches; so that the centre arch will not then have more height for navigation than the two arches adjoining the centre arch now have; and when we inform you, that at high water of good tides, the centre arch is the only one which some of the steamers can conveniently pass under, we think you will allow with us, that the proposed lowering will, in such cases, be rather a practical evil, as it will take from the convenience of what is now the least convenient bridge for navigation, to say nothing of the liability to the ribs being injured by masts and chimneys striking them.

The *artistic* point of view is the last insisted on by Mr. Barry; and on this, what we may say, is with a due respect to his better judgment and taste in matters of architecture. The contract with Mr. Cubitt does not alter the elevation below the crown of the arches; but, as you are aware, we have long suggested that a new elevation for the bridge, after the Norman style, would be a great improvement. In this, however, we would not propose to reduce the magnitude of the features of the bridge, considering that simple boldness, and strength, are essential qualities in a bridge over the river Thames, in London; and if so, that it is scarcely fair to reduce the parts of the bridge because those of the elegant florid edifice, which is now being erected near it, are small. For palace architecture, the latter may be the best, and we do not venture an opinion as to the effect of Mr. Barry's work, in which our professional employment was confined to the construction of the coffre-dam and the river wall; but for a bridge, particularly in a city, with constant and heavy rough trade under and over it, the style of architecture ought, we conceive, to be more masculine. May not the new Houses be better displayed thus, than by accordance of style? The beauty of the detail of the new Houses is very great; the length, 800 feet, without, at present, any striking feature or variety, also great; but we submit, whether an additional 800 feet of according composition and style, of still lower elevation, would not rather tend to render the "ensemble" dull and flat rather than effective? The style of the new buildings must stop somewhere. Can it do so better than at the bridge, which, as we have already said, appears to require a character different from the Houses of Parliament? If both faces of the arches are proposed by Mr. Barry to be alike, would there not be a want of accordance between the north face of the bridge and the buildings and mansions near to it, and which there is, we presume, no intention of altering? Is a continuance of the same style required for so great a length as the Houses and the bridge together, although the pointed may be the prevailing character of the building? Does not precedent reply to this in the negative, and prove it, by the fact that the periods of the original erection and of the additions that have from time to time been made to some of our finest buildings may be discovered by the style; the Saxon, the Norman, the Pointed, and varieties of each being found in the same building, and yet the "ensemble" not inharmonious. We hope, therefore, that the superstructure of the bridge, though it may be different from the Houses of Parliament, may not be discordant.

Westminster-bridge has been where it is, and as it is, for a century: it was there when the designs for the new Houses were made, and we never heard that to pull down Westminster-bridge to nearly low water, was to be a necessary accompaniment to the adoption of any of the designs. If you and the other commissioners had known that such alterations were contemplated, you would not, we are sure, have allowed the works to have proceeded as they have done, until nearly two-thirds of the whole to above high water had been completed, including the renewal or repair of the arch stones.

We may name here an objection to the form which Mr. Barry has proposed for the arches, as tending to lessen the stability of the bridge. Labelye considered that by adopting the semi-circular arch, which presses vertically upon its piers, each pier might be considered an abutment, so that if one arch were to give way, the piers would support all the others. From the great height at which the proposed pointed arches spring from the piers, and their greater lateral pressure or thrust upon the piers, the above would not be the case. On the contrary, the failure of one arch would, we conceive, cause the destruction of all the piers and arches. This consideration is not to be disregarded in a bridge, the piers of which have been so badly founded, that to support them has been a constant expense, and is at this moment a source of considerable anxiety; although the works we have in band, if as successful as hitherto, will render the piers much more secure than they have ever been; we hope, perfectly so.

On the whole, therefore, we have reason to be pleased, that Mr. Barry approves the various improvements in the bridge which the commissioners have contemplated, and, with one exception, contracted for. The only addition he makes to them is, the substitution of the pointed arch, which, for the reasons stated, we cannot advise. We agree to the advantage, in point of taste and utility, of keeping the road-way of the bridge low; we have designed doing this as far as can be done, having regard to the funds of the commissioners, and therefore without disturbing the present arches. There is a way by which the height of the road-way might be reduced below what either Mr. Barry or we have proposed, at one-fourth of the expense of his plan (which would, we think, much exceed his estimate), and without lowering the soffit of the arch, or diminishing in any way the convenience of navigation; but we avoid entering upon, or committing ourselves to this, until we have considered the subject more in detail, and understand it to be the wish of the commissioners that we should do so; for the works we have already recommended may go as far as their unassisted funds would justify.

We have the honour to be, Sir,
Your obedient Servants,
WALKER & BURGES.

23, Gt. George-st., May 31, 1843.

The Rt. Hon. the Speaker of the House of Commons.

A Letter from Mr. Barry *to the* Speaker, *in answer to a Report of* Messrs. Walker & Burges, *upon the proposed Alterations.*

Sir,—As Messrs. Walker & Burges have thought proper to print and publish a Letter, addressed to you as Chairman of the Commissioners of Westminster Bridge, relative to the suggestions I ventured to offer for the improvement of that bridge, in a Report which I made to the Fine Arts Commissioners, of the 22nd February last, I feel called upon to address to you a few observations, for the information of the Board over which you preside, chiefly with the view of removing several misconstructions which that letter is calculated to occasion.

Westminster Bridge has long been considered extremely inconvenient, as well as unsightly, and, from its proximity to the new Houses of Parliament, is generally felt to have a most injurious effect upon the appearance of that building. As a remedy for these defects, the main objects to be attained are evidently to lower the roadway, to increase the waterway and head-room under the arches, and to reduce the mass of the bridge to the greatest practicable extent. In order to accomplish these objects in the most effectual manner, it appears to me to be necessary to rebuild the bridge; but as the Commissioners were incurring a large outlay in securing and extending the foundations,, I recommended in my Report above alluded to, that the rebuilding should be confined to the superstructure.

Previously to noticing the several points of Messrs. Walker & Burges' Letter, I would beg to observe, that the suggestions contained in my Report were offered merely as hints for the consideration of the Fine Arts Commissioners, and not as mature opinions founded upon a careful practical investigation with reference to execution, in which I stated most distinctly that I did not wish to be engaged. I presumed that if the Fine Arts Commissioners deemed those suggestions worthy of attention, they would refer them to the Commissioners of the bridge, by whom they would be duly considered, and, if approved, carried into effect by their own officers.

I now proceed to notice the several observations of Messrs. Walker & Burges upon the suggestions contained in my Report. With reference to those upon the relative properties of circular and pointed arches, and to the authorities which they quote in depreciation of the pointed arch as applied to bridge-building, I beg to state, that the hypothesis in which those authorities are said to concur, namely, that a pointed arch requires a greater pressure than a circular arch at the crown, is at direct variance with the opinion of Professor Moseley, of King's College, one of the highest authorities in such matters, who in a letter to me on the subject states, "that a pointed arch does not necessarily require a great pressure, or indeed any pressure, upon its crown, to prevent it from falling, and that the reasoning upon which an opposite conclusion is founded in Messrs. Walker & Burges' Report is erroneous." Both theory and practice confirm me in the opinion which I have advanced in my report, that a pointed arch requires less thickness at the crown than is usually considered necessary for a circular arch. As, however, it might possibly be inferred from the observations of Messrs. Walker and Burges that the arch which I have proposed is not strong enough for its purpose, although they do not attempt to prove that such is the case, I have thought it right to enter into a careful investigation of its properties; from which I am fully convinced, that I have not carried the principle which I have advocated far enough; and that, considering the insignificant span of even the largest of the proposed arches, it would be no great effort of engineering science to reduce the thickness of its crown to nearly one half of what is proposed by Messrs. Walker and Burges; by which means the lowering of the road-way over the centre arch might be carried to the extent of 6 feet 6 inches, instead of 3 feet 6 inches, even without reducing the clear height of the centre arch as I have proposed; if such reduction were deemed to be an objection of any importance. In this opinion I am confirmed by the examples of numerous stone bridges both in this and other countries, and also by the judgment of several eminent engineers and mathematicians of the present day.

With reference to the loss of water-way, which I stated was occasioned by the haunches or spandrils of the present arches at high water, I ought perhaps to have explained that I referred to such portion only of the water-way as is affected by those obstructions, which might, however, I think, have been inferred. With regard to the removal of these obstructions, I do not agree with Messrs. Walker and Burges in thinking that it would be unproductive of any useful effect upon the "currents and falls;" and I consider the arguments in support of their opinion to be fallacious, inasmuch as they are founded upon the assumed level of high water according to Trinity standard; whereas the present ordinary spring tides, as they must be well aware, rise considerably above that level; on one extraordinary occasion recently as much as 3 feet 6 inches. That some practical good would be effected in giving more head room for craft near to the piers, by raising the springings of the arches according to my suggestion, Messrs. Walker & Burges admit; and I conceive that this advantage alone ought to be a sufficient inducement to remove the present arches, and to substitute others of more convenient form; but when it is considered that the opportunity would be thereby afforded of lowering the roadway to nearly double the extent proposed by Messrs. Walker & Burges, without producing the slightest injury to the navigation of the river, the advantage as regards the convenience of the public is so much enhanced, that the propriety of rebuilding the superstructure cannot, I think, be doubted. With respect to my proposition of lowering the centre arch 18 inches, which it appears Messrs. Walker & Burges consider will be "rather a practical evil," as affecting the navigation of the river, it is necessary that I should call your attention to the clear height of the middle openings of some of the bridges above Westminster Bridge, as they have done to those only which are below the bridge. While the clear height of the centre arch of Westminster Bridge is 26 feet above Trinity standard of high water, the centre openings of the modern bridges at Vauxhall and Hammersmith are of the respective heights of 25 feet 4 inches and 16 feet 1 inch, to say nothing of those of Battersea and Putney Bridges, but which I admit are extremely inconvenient. As the largest steamers which pass up the river are those which ply between London Bridge and Richmond, and as their funnels are jointed so as to allow of their passing even under Putney Bridge, the height of the centre opening of which is only 11 feet 2 inches above high water, it cannot be imagined that the lowering of the centre arch of Westminster Bridge to the extent which I have proposed, can really be an objection of any importance as regards the navigation of the river, while the great object that would be thereby gained by a farther depression of the roadway, to the extent of 18 inches, reducing its inclination to 1 in 40, instead of 1 in 24, as proposed by Messrs. Walker and Burges, would be of the greatest advantage to the traffic over the bridge, as well as to the effect of the new Houses of Parliament when viewed from it, a point which I submit ought not to be disregarded.

Messrs. Walker and Burges state in their letter, as an objection to the form of arch which I have proposed, that the failure of one

arch would cause the destruction of all the piers and arches; a consideration which they say is not to be disregarded in a bridge, the piers of which have been so badly founded, that to support them has been a constant expense, and is at this moment a source of considerable anxiety; although they further state, that the works they have in hand, if as successful as hitherto, will render the piers much more secure than they have ever been; they hope, perfectly so. The part of this objection which is founded upon the lateral thrust of arches, will apply with equal force to all arches of a segmental or elliptical form, which are generally adopted in modern bridges, and even to semicircular arches, of the lateral thrust of which I will not affect to suppose Messrs. Walker and Burges to be ignorant, although in the allusion which they make to Labelye's opinion on that subject, they leave it to be so inferred. With regard to the other part of the objection, namely, the failure of the foundations, it may surely be assumed that Messrs. Walker and Burges would not have recommended the very serious outlay which is now being incurred in securing them, if they conceived there was any risk whatever of their ultimate failure; but if a possible failure is notwithstanding to be taken into consideration, can a more powerful argument be advanced in favour of a new superstructure, than that the weight upon the piers might thereby be reduced at least one third?

To Messrs. Walker and Burges' design for a new superstructure I object, principally because it does not accomplish the main objects for which a new superstructure is, in my opinion, desirable, namely, the reduction of the mass of the bridge, and the lowering the roadway to the utmost practicable extent; neither does it afford any improvement whatever in respect of the navigation of the river; the accomplishment of which objects is, in my opinion, of far greater importance, both for the sake of public convenience and architectural effect, than the style of architecture to be adopted.

As to the principles which Messrs. Walker and Burges consider should govern the nature of a design for a bridge over the Thames in London, I entirely disagree with them; I conceive that the height of the opposite shores and buildings upon them should mainly determine the æsthetical character of the design. If, as in Waterloo Bridge, where the shores are high, one being naturally so, and the other raised, and the road-way is level; where the superstructure of a great public building like Somerset House is wholly above the level of the roadway; and where the bridge groups with the substructure of such an important building,—the character of the design cannot be too bold and massive; but if, as at Westminster, where the shores are low, and the bridge must in consequence group with the superstructure of an extensive work like the New Houses of Parliament, and where the parapet must, in consequence of the height required for the centre arch, assume a curved line, which is an element rather of elegance than of boldness, the character of the bridge should be light and graceful.

Upon the taste of Messrs. Walker & Burges' design for a new superstructure in what they term the "Norman style," I forbear to offer any criticisms in detail, as the conditions which should be observed in a bridge are, in my opinion, wholly at variance with the essential characteristics of that style; nor do I conceive it worth while to make any remarks upon their observations relative to points of taste, including those especially which refer to harmony and contrast between the bridge, the New Houses of Parliament, and the neighbouring buildings, as they seem to me to furnish their own comment.

In conclusion, I beg to add, that I still remain of the same opinion as I expressed in my Report to the Fine Arts Commission, as to the necessity of a new superstructure to Westminster Bridge upon the principles therein advocated; and as a favourable opportunity is now afforded of carrying into effect that great public improvement, at an outlay, moderate, when compared with its importance, I trust the Commissioners will not be indisposed to take my recommendations upon this subject into their most serious consideration.

I have the honour to be, Sir,
Your very obedient Servant,
CHARLES BARRY.

32, Great George-st., July 10th, 1843.

The Rt. Hon. the Speaker of the House of Commons.

REFERENCES TO THE WOODCUT.

Heights of Soffits, or the clear heights of Centre Arches of Bridges on the Thames, above Trinity High Water.

	ft.	in.
1 Southwark	29	6
2 London	29	0
3 Blackfriars	28	0
4 Waterloo	27	6
5 Westminster, if reduced as proposed by Mr. Barry	24	6
6 ———, at present	26	0
7 Centre line.		
8 High water, Trinity stardard.		
9 Half ebb.		
10 Low water.		

COMMUNICATION WITH IRELAND BY HOLYHEAD, ORME'S BAY, OR PORT-DYN-LLAEN.

If Ireland is ever to become a useful member of the United Kingdoms, and partake of the advantages which the other portions of the empire have derived from manufacturing industry and commercial enterprise, a safe, rapid, and certain communication must be established between it and Great Britain. This fact has been acknowledged by all modern statesmen, and large sums of money have been expended with a view to the accomplishment of the object. Holyhead has been considered the most desirable port for embarkation from the British shore, but up to the year 1815, the road which connected it with the metropolis was of the most wretched description. Under the management of Telford great improvements were made, and it is now the most perfect road in the world. But a new mode of conveyance has since been introduced in various parts of the country, and the communication with Ireland must, at no distant period, have the advantage of a railway, which will greatly supersede, though by no means render useless, the present coach road. The certainty that private enterprise will soon select this as a suitable situation for the investment of capital, has suggested the inquiry whether Holyhead is the best port to secure all the advantages required by the packets employed in completing the communication between Great Britain and Ireland. The government has, therefore, given instructions to its officers to survey the coast, and to report upon the relative advantages of different places, and it is to these Reports in particular, that we wish to draw the attention of our readers. At some future period we shall, probably, examine the various lines of railway which have been projected, but no opinion can be formed upon these until it has been decided which harbour is best suited for a packet station, taking into consideration the three principal things required,—safety, rapidity, and certainty.

Mr. Telford, in his First Report to the Commissioners, in 1824, says:—

"This harbour continues to afford all proper accommodation to the steam packets, and also very considerable protection to trading vessels in stormy weather. I have, more than once, seen above one hundred vessels in at a time; but this crowding within the protection of the pier is a serious interruption to the steam packets; and for want of sufficient room, two trading vessels, last winter, of large burthen, having failed in obtaining a berth, were driven to and wrecked on the opposite or eastern shore just beyond the harbour mouth."

In 1827, the same reporter says:—

"This harbour is now brought to as perfect a state as was formerly contemplated; it continues not only to afford protection and accommodation to the steam packets, but in stormy weather frequently protects above a hundred sail of coasting vessels; but for those of larger dimensions (as shown by the shipwrecks of last winter), the

more extensive accommodation of an asylum harbour (as formerly suggested) is urgently demanded."

In 1828, Mr. Telford reports:—

"This very important station has now been rendered nearly perfect as a packet station, although sundry matters of minor importance yet remain to be completed."

In 1833 Mr. Telford added to his Report a letter from Hugh Evans, the harbour-master of Holyhead, as confirmatory of the opinions he had expressed in his former Reports.

"I beg leave to send you a general statement of occurrences at this harbour during the late winter months, which will be found to confirm all former Reports on the advantages of this place as an asylum harbour, as well as the necessity for making still greater improvements, to afford refuge and security to shipping in stormy weather.

The number of ships and vessels that have taken shelter within the pier since 1st October, 1832, to April 1833, is 591, making 45,503 register tonnage, exclusive of His Majesty's packets; and I have much satisfaction in stating, that the latter, in their arduous midnight duty in arriving and sailing with the London mail on board, have not been put to any delay or inconvenience from the numerous trading vessels, who are enabled at night time, by the guidance of the local lights, to run for the entrance of the harbour, and anchor; a circumstance that cannot be prevented, and causes the greatest responsibility."

From these statements it is evident that Mr. Telford considered Holyhead, as a packet station, for the communication between the British and Irish coasts, to be all that could be desired, though important works were required, to render it a harbour of refuge adequate to the wants of the vessels frequenting the coast.

By a Treasury minute, dated 14th October, 1836, a suggestion was made to the Admiralty, that it would be desirable "to survey the harbour of Holyhead, or the line of coast best calculated for a direct communication between the Metropolis and Dublin, with a view of ascertaining whether the existing ports of Holyhead and Liverpool, or any other ports in that part of the coast of Great Britain, would, in the judgment of experienced naval surveyors, furnish the greatest facilities for steam communication by packets across the Channel." In consequence of this communication, Capt. Beaufort was ordered by the Lords of the Admiralty to make the required survey, which was immediately done, and on the 4th of November he delivered the following Report.

"As long as the Dublin mails are carried by coaches on common roads, the best place of embarkation in every respect will be Holyhead, which is only 62 statute miles from Kingstown harbour, and which only requires a little elongation of the pier in order to admit a larger class of steam vessels at low-water.

"But if a railroad should be constructed for that purpose, it would be probably led to another port, because it is not likely that a steam carriage with a loaded train would be allowed to traverse the present chain bridge at Bangor, and a new bridge there, on arches, would add enormously to the expense of the undertaking; besides the objection that would be raised to such a bridge from the obstruction it would give to the navigation of the Strait.

"Two places have been proposed as suitable termini to a direct railroad, and either of them easily capable of being converted into a pier harbour for steam packets; Port Dynllaen, on the western shore of Caernarvonshire, and Orme's Bay on its northern shore, and both have been sufficiently examined to warrant the following statement without further survey:—

"Port Dynllaen is 69 miles from Kingstown, and the courses would be W.N.W. and E.S.E., so that the most prevalent wind (south-west) would be a side wind both ways, an advantageous circumstance to steamers, as it enables them to steady themselves by canvass. From this place a survey of the interior by Mr. Rastrick, civil engineer, shows that a feasible line of railroad may be obtained through the Merioneth mountains, so as to connect it with the great trunk railroad now constructing from London to Liverpool.

"Orme's Bay is 91 miles from Kingstown; but, as the packets would have to round the north point of Anglesea, the course across the Channel would be W. by S. and E. by N., thus bringing the usual wind and sea nearly a-head or a-stern: on the other hand, a much shorter and more level railroad than that from Port Dynllaen would connect Orme's Bay with the above-mentioned trunk; but the great difference of distance of the two places from Kingstown leaves the comparative balance of their merits much in favour of Port Dynllaen."

In January, 1840, a further report was made to the Lords of the Admiralty, by Sir James A. Gordon and Captain Beechey, upon "the best means of communicating between London and Dublin, and more immediately upon the relative capability of the ports of Holyhead, Orme's Bay, and Port Dynllaen, for expediting and receiving the steam packets to and from Dublin." We cannot now insert this report entire, although it is quite worthy of examination, but must content ourselves with a statement of the conclusions formed by these gentlemen:—

"We have the honour to acquaint you," they say, "for the information of their lordships, that we are decidedly of opinion that both Orme's Bay and Port Dynllaen are under such disadvantages, as compared with Holyhead, whether as regards the distance, the passage, the convenience as a station, or the expense of constructing works, that we have no hesitation in recommending Holyhead as the most fit and eligible point for the departure and arrival of the packets on the eastern side of the Channel."

In consequence of this report, in connection with one delivered at the same time by Sir Frederick Smith and Professor Barlow, a petition was soon after presented to the House of Commons by J. R. Ormsby Gore, Esq., and others, chiefly land owners in the county of Caernarvon, praying the House to refer the examination to a select committee. In this petition the assumed facts are denied as well as the conclusions, and reasons are given for the choice of Port Dynllaen, in Caernarvon Bay, in preference to Holyhead. In March, 1842, a select committee to inquire into the post-office communication between Great Britain and Ireland was ordered, and in April a committee was nominated. This committee reported that they did not inquire into the relative capabilities of Holyhead and Port Dynllaen, but refer to certain documents which we have already mentioned, and to others in the appendix of their report. They further add,—

"Your Committee would earnestly impress upon the House and the Government the importance of procuring without delay such further information as may be deemed necessary, in order to a satisfactory decision between the two ports of Holyhead and Port Dynllaen; and your Committee submits, when such decision shall have been made, that no time should be lost, or reasonable expense spared, for the purpose of establishing, upon the foregoing principles, the most direct, certain, and rapid line of communication between this metropolis and the seat of government in Ireland."

In consequence of this expressed desire for further information, the Lords Commissioners of the Admiralty instructed Capt. Back and Capt. Fair to examine the harbours of Holyhead and Port Dynllaen, with reference to their capabilities and position as packet-stations for communication with Dublin. Mr. Walker was soon after ordered to examine those places with the same object, but also to ascertain the facilities they may severally afford for the formation of a harbour. These reports have now been delivered, and it was chiefly in reference to them that we introduced the subject to our readers.

REPORT ON HOLYHEAD AND PORT DYNLLAEN HARBOUR. BY CAPTAIN BACK AND CAPTAIN FAIR.

SIR, *Holyhead, June 9, 1843.*

In obedience to the commands of the Lords Commissioners of the Admiralty, conveyed in your letter of the 21st of May, de-

siring that we should proceed to Holyhead and Port Dynllaen to examine those harbours on the spot, with reference to their capability and position, for the purpose of ascertaining which, in our opinion, is the most eligible to be established as the port of communication with Dublin for the packet, &c., we have the honour to acquaint you, for the information of their Lordships, that we have proceeded to and examined those places by land and sea, and, without bias of any kind from local interests or otherwise, but having regard solely to the quickest transit, consistent with safety, from one side of the Channel to the other, have given the subject and all that bears upon it our best and most attentive consideration.

As regards Port Dynllaen, we have to report as follows:—

1. Forming, as it does, a small inner bay or cove within Caernarvon Bay, it is entirely exposed to the winds blowing from all points between north-west by north and north-east, and though sheltered from the prevailing south-west winds, yet the gusts from the land are said to rush down with such violence between the mountains, and more especially from the two principal hills, called the Rivals, as to endanger the safety of small vessels endeavouring to get in with the land.

2. Port Dynllaen has no good leading mark to guide to the anchorage, for though the Rivals are conspicuous enough in fine weather, yet, during the settled fogs and occasional mists, which are here not uncommon, the adjoining mountains are so nearly alike, that the most experienced person might be deceived, and thus brought into difficulty and danger.

Our own observation and inquiries confirmed the impression which we received from the aspect of the coast, and led us to the conclusion that, as well in thick weather as during occasional storms, Port Dynllaen was liable to be, and was, in fact, obscured, whilst Holyhead was comparatively free and clear.

3. After maturely considering and endeavouring clearly to estimate the position of Port Dynllaen with regard to the prevailing south-west wind, the nature of the flood tide, and the long ebb tide of eight hours, causing an indraught into, and sweeping round, the whole of Caernarvon Bay; and the necessity, or at least the prudence, of making the passage by the north of the Kishlight: we do not perceive any advantage that could be gained by starting from that port; whilst on the other hand are to be taken into account the risks inseparable from a deep tidal bay, foggy weather, and occasionally a lee shore.

For these and other reasons, we have come to the conclusion that Port Dynllaen is not in itself eligible as a port of communication with Dublin.

We have formed this opinion independently of other considerations to which our attention was not so directly called, but which, nevertheless, it would not be proper wholly to overlook,—we mean the particular site of the port, and its capability for the erection of buildings such as would be indispensable for a regular packet establishment.

On this subject we would only remark, that there is no space between the beach and the precipitous banks of earth and sand which rise above it to the height of 100 to 120 feet for more than one, or perhaps, in a favourable spot, two houses abreast; and that the construction of docks could only be achieved by great labour and still greater outlay.

Such being our conclusion as to the unfitness of Port Dynllaen for a packet station, we do not feel called upon to offer any observations on its eligibility or capacity for a harbour of refuge.

Of the harbour of Holyhead we have to report as follows:—

The bay of Holyhead seems formed by nature for a place of shelter, and, if there be anything still wanting to make it complete, the defect may be easily supplied.

Point Carmel and the Skerries on one side, and Holyhead and South Stack on the other, render the entrance equally easy and certain by day and by night; and the light at the extremity of the pier is a sure guide into the harbour.

The Race off the head would only be formidable during a strong opposing wind and tide, and, on the other hand, it becomes of the utmost use in dense fogs, by indicating at once the correct place of the vessel, and thus enabling her to make for her port.

The Stag rock lies out of the course of the packets, which almost invariably round the buoy of the Outer Platters, in preference to passing within them, as may be done at certain times of the tide; but, if even by any accident the packets should go further out, they would always find 15 feet at low water; a depth more than sufficient under all circumstances to float them over that rock without danger.

We do not discover anything else which could even be deemed to be an obstruction to the free passage of a steamer in or out of Holyhead; and with respect to the crossing of the Channel, and the time required for doing it, making all due allowance for winds, tides, and adverse weather, we are clearly of opinion that it can be performed on an average nearly an hour sooner, and consequently with less consumption of fuel, from this port than from Port Dynllaen.

Above all, we cannot forbear laying much stress on the advantage of so conspicuous a landmark as Holyhead, which, being generally free from clouds, and standing boldly out, apparently isolated from the neighbouring hills, is soon descried and made for with the greatest confidence.

Finally, although it appears that the packets, through a period of 13 years, have been occasionally detained a few hours by strong gales, yet in no instance, so far as we can learn, have they ever failed in conveying the regular mails to and from Kingstown, nor is there, we believe, a single loss on record.

It is, therefore, our unqualified opinion, that both as to "capability and position" Holyhead is unquestionably the most "eligible" harbour on the coast as a port of communication with Dublin.

Having thus answered, to the best of our abilities, the question proposed to us by their Lordships, it may not be irrelevant to add a few words on the present state of the inner harbour of Holyhead, and we would respectfully suggest, that it requires only to be deepened by dredging and excavating, and the removal of the comparatively few rocks, and cropping out of the mud, to render it perfectly available for every purpose that can be desired.

And although the consideration of such alterations and improvements belongs more properly to the province of the civil engineer, we should not think that we had entirely fulfilled our duty were we to refrain from expressing a hope, that the proposed plans for the formation of an outer harbour, as supplied to us from their Lordships' office, should be acted on.

Holyhead would then, in our judgment, become an excellent refuge harbour, and as such would be of incalculable use to vessels sailing along the rocky and dangerous coast of North Wales.

We have the honour to be, Sir, your obedient servants,

G. BACK, Captain.

The Hon. Sidney Herbert, &c. R. FAIR, Captain.

The instructions given to Mr. Walker, dated 20th June last, were

"To proceed to Holyhead and Port Dynllaen, to examine those places with reference to their capability and position, and the natural facilities which each may afford for the formation of a harbour, with a view to ascertain which is the most eligible to be established as the packet station and port of communication with Dublin.

"To ascertain with which of the two ports above named there may exist the greatest facility for railway communication with London, regard being had to the comparative cost of effecting such communication, and the other considerations bearing on the point.

"To make plans, with an estimate of the cost of constructing or improving at each place a harbour and works necessary for a packet station for vessels of the class now running between Liverpool and Kingstown, namely, of 900 tons, and drawing 10 feet 10 inches of water, and for a refuge harbour for the Channel trade."

That portion of the Report which relates to the railway communication does not at present come under our consideration, so that we shall only place before our readers the opinions of Mr. Walker upon the relative merits of the two harbours as packet stations, and the cost of the works he proposes to execute to make them harbours of refuge.

"I have seen Commander Tudor," says Mr. Walker, "since his return to town from Porth-dyn-llaen, but have not yet received from him the report of his survey and his opinion. The importance of the general question, and the pressing applications to me from various

quarters for my Report, do not justify my longer delaying to state my opinion on the facts I have ascertained of the advantages and capabilities of Holyhead and Porth-dyn-llaen, for a packet station and harbour, and of the coast line of railway to both harbours, for the communication between London and Dublin, but I crave leave to make such further modification as to comparative merits as the reports I may receive of the south line, and of Captain Tudor's observations on Porth-dyn-llaen harbour, may in justice require of me. I would remark, and have stated to the parties, that as Porth-dyn-llaen may be reached either by the inland railway or by the line between Chester and Bangor, so Holyhead may, perhaps, be reached, either by the coast line of railway crossing the Menai Straits near Bangor, or by an inland line through Shrewsbury or Worcester, crossing the Straits into Anglesea near Caernarvon.

I now proceed in the order pointed out to me in your letter. First, to give my opinion of Holyhead for a packet station, and also for a harbour of refuge: these being two distinct questions. My instructions may be taken as having reference chiefly to the engineering part of the subject; but it was impossible for me to do justice to this without extending my consideration out to sea, and even across the Channel, and considering how the day and night beacons, the landmarks, and the shoals affect the passage and the entrance into the harbour. I have therefore examined the charts and perused the Reports on this subject, particularly that of Sir James Gordon and Captain Beechey, which, with the observations on the petition of Mr. Ormsby Gore and others, and the replies to these observations, together with the opinions of the various naval officers, including Lieut. Sheringham, appear to me to have completely exhausted the naval part of the question, and must be well known to the Lords of the Admiralty, and all who have attended to the subject; so that very little need be said by me on that head. The natural advantages of Holyhead are described to consist of its being the nearest point of land to Dublin, being situated under a projecting and very conspicuous headland, giving facilities for keeping out at sea in case of missing or being unable to enter the harbour, the Skerries forming another good sea-mark, the entrance being free from bar, and the shelter which the bay affords to vessels from all winds, excepting north-west and north-north-east.

This bay, and the shallow estuary now forming the inner Holyhead harbour, appear always to have been a shelter for coasters; and the creation of a town there, before art had done almost anything to assist nature, confirms the opinion. It was not until 1715 that a light was shown upon the Skerries, nor was the South Stack lighted until 1809. These lights being one on each side of the harbour, at the distance of eight miles from each other, together with the pier, and the excellent light upon it, between the two outer leading lights, have much added to the natural advantages of Holyhead, and mark the direct course to, and the entrance into, the harbour in a superior manner.

The Stag Rock, which has now 15 feet upon it at low water of spring tides, and the Platters, which are within half a mile of the shore, are the only sunk rocks in the direct course of the entrance. There is one uninterrupted course, clear of shoals, between Holyhead and Kingstown, with the exception of the Burford Bank, which has upon the shoalest part two fathoms at low water spring tides.

The prominent disadvantages (within the "Head") of Holyhead in its present state, as a harbour of refuge, are, that the bottom of the bay is bad holding ground, so that vessels at anchor there are exposed during heavy northerly gales to great danger of their anchors dragging, and their being driven upon the rocks, which, with some exception, encompass the bay: also, that, from the pier pointing so much towards the shore, there is not room for a vessel to work in with a strong westerly or to get out with an easterly wind without danger of getting upon the rocks. I have not received a list of the losses and damage that have occurred. The depth alongside the pier for 300 feet is 10 feet at low water. This decreases rapidly, leaving but little space, even near the entrance, covered with water at low water of spring tides, and one half of the estuary or inner harbour is dry before half ebb.

As a harbour of refuge, therefore, Holyhead has at present but little pretensions, and yet it is much used by wind-bound coasters. I was informed by Captain Evans, the harbour master, that during the three first months of this year 394 vessels used the harbour for shelter, or being wind-bound or laid up.

As a mail-packet station, Holyhead has, even now, much to boast of. The certainty has indeed been extraordinary. Lieutenant Jones informed me that during the six years he has been on the station there has been no instance of his packet, in the very worst weather, not having started so soon as the mail was on board, or of having put back after having started, or of being unable to enter after approaching the harbour. A few of the crossings have, however, been long. During the six years he has had one passage of 21 hours, and two or three of 18 hours. Commander Kaines also, the agent for all the packets, stated that the Holyhead packets had never missed starting, and that they can make the passage at all weathers. Lieut. Smail, of the Zephyr, said that, excepting about six times in winter, during excessive gales, his longest time has been $7\frac{3}{4}$ hours, the quickest $5\frac{3}{4}$, and the average $6\frac{3}{4}$ hours. This information, added to the letters which are attached to Sir James Gordon and Captain Beechey's report from the same, and from other officers who had left the station, is very strong as an argument in favour of Holyhead in even its present state.

I have appended to this report a copy of the letters which you have lately sent me from the officers now commanding the Liverpool and Dublin Government and other packets; also the evidence of Mr. Robert Thomas, now commanding a steamer between Rhyl and Liverpool, who is in favour of Holyhead; also that of Mr. Thomas Thomas, master of a schooner in the slate trade out of Caernarvon, who is decidedly for Porth-dyn-llaen; and I believe, from the inquiries I have made, that the majority of masters in the same trade would give a similar opinion.

That the present regularity and despatch would be still added to by more powerful packets, and an improved packet station, cannot be doubted; and I beg now to refer you to the accompanying design for improving and enlarging Holyhead Harbour. It may be considered as of three divisions:—

Firstly, A steam-packet pier, sufficient to give good accommodation to the proposed larger packets.

Secondly, A breakwater pier, to form, upon a cheaper plan, a shelter to shipping from the northerly winds.

And, thirdly, The further extension of the landing pier in the same direction as before, and returning the end over the Stag Rock, towards the termination of the breakwater, thus forming an enclosed harbour for refuge and the convenience of trade.

Each of these stages may be considered an independent work, and would be useful without the other. The third or last division is a large work.

Returning to the packet pier (lettered A B on the design No. 1) its direction will be east by south nearly,* its length 700 feet, and width 80 feet, both sides walled and faced with ashlar, as the north side will form also one side of the future harbour. The depth at low water spring tides at the inner end 12 feet, and at the outer end 18 feet. A return jetty of 100 feet is proposed at the outer end.

The estimate of this division is £78,000

Second. The break-water (lettered E F G on the drawing No. 1) is designed to be carried out from the rocks at the north end of Salt Island, in an east by south straight direction, 500 yards, and there returned by a curve to a southerly direction. Its termination or head will bear north-east by north of the Stag Rock, from which it will be distant 250 yards.

This arm, as will be seen by the plan, will shelter a large space (upwards of 70 acres) from all the heavy seas to which it is open. The low water depth, excepting for a very small space on the west side, will exceed 18 feet, the average being 24 feet. It will also protect the north side of the steam-packet pier, so that vessels may come alongside it. The estimate of this work, including the removal of the Inner Platters, is 177,000

These two works, therefore, amount to £255,000

By the third division, it is proposed to extend the packet pier 750 feet (from B to C, on the drawing No. 1), and to project a jetty 150 feet to the southward. Thus the present pier, with the pier before described, and this extension, will form the south side of the harbour of

* The bearings are all by compass.

refuge. A return in a north-east by north direction for a length of 900 feet (lettered C D on the drawing No. 1), will leave an entrance of 300 or 350 feet wide between it and the termination of the breakwater, making a complete harbour of refuge of about 80 acres, in which the large class ships will be afloat at the lowest water. The cost of this work will be 145,000

The amount of the three works is thus £400,000

When they are done, the accommodation will be of the first order for steamers, the length of deep water quay being not less than 3900 feet, of which 2900 feet are within the enclosed harbour. There will also be an excellent harbour of refuge, which ships of the largest class may enter and leave with almost all winds, be always afloat, and in perfect safety while in the harbour.

As I before said, each may be finished independently of the other, and each will be most useful after its kind, but not perfect as a whole, because the breakwater alone would not give such complete refuge as when made an enclosed harbour by the completion of the third division. The two first divisions, amounting to £255,000, correspond nearly with what I have afterwards to submit for Porth-dyn-llaen, where an enclosed harbour is not proposed.

Holyhead harbour, thus made, would be less in point of area than Kingstown, but it would be superior in point of accommodation for steamers, and would possess the advantage of an entrance protected against all winds, which Kingstown does not. Holyhead has also the advantage of a good graving dock, and an establishment upon the Crown estate for fitting up and repairing the machinery of the packets. The present inner harbour, though shallow, is useful, and will continue to be so for small craft; its area at high water is about 75 acres. I have drawn a straight line along the west side of the proposed harbour of refuge. This frontage will belong to the Crown, and if a wall were built in that line, and the reclaimed space added to the Government yard, the present area of that establishment would be nearly tripled. Her Majesty's steam or other vessels might be brought into the harbour for examination and repair; part of the space on the west side of the harbour might be used for graving docks, slips, and other conveniences.

Having already described the disadvantages of Holyhead in its present state, it is but justice to say now, that I think the works I have just described will almost entirely remove them. Thus, the bad holding ground outside the harbour will be of very little consequence if vessels, by entering the harbour, have little or no occasion to anchor outside; and the same reason renders the rocks round the bay comparatively harmless. I am not aware that, in my department, there can be an objection to the plan but the expense; and as doubling the expense quadruples the area, and diminishes the swell, I consider that if made at all the harbour should be capacious.

A passing toll of one halfpenny per ton would produce £10,000 per annum, but this would probably be objected to by the trade. Considerable revenue might be derived from ships using the harbour for shelter; and perhaps it is not speculating too largely to expect that the safe access and speedy communication with the capital may tempt ships, particularly during contrary winds, to go into Holyhead for landing their passengers and valuable goods of little bulk, and that passengers may prefer embarking there to higher up the channel. There would be ample quay room for the accommodation of such vessels.

To bring the railway down to the quay, the entrance into the inner harbour on the west side of Salt Island would have to be crossed, which may be done, and that passage filled up for this purpose without injury, compared with the advantage of bringing the mail and passengers quite down to the steamers. The inconvenient distance from the starting point is at present complained of when the packets arrive or leave after dark.

Having thus given my opinion of Holyhead, with its capability of improvement, I have now to state the result of my observations upon Porth-dyn-llaen. Its present state may be considered as a state of nature, scarcely anything having been done to improve it; nor does it appear that any one connected with shipping has thought it his interest to settle or build near it for furnishing supplies to the vessels that may have frequented it. There is no shop or store of any kind nearer than Edern (one mile), nor is there the appearance of there having been one; a proof that if on occasions a great number of ships have taken advantage of the harbour, these occasions have not been frequent, or the ships must have remained a very short time. Yet this may not be conclusive against Port-dyn-llaen having important natural facilities, for developing which a judicious application of science might do much. There are points in which I consider it has advantages. And the very strong opinions in its favour which have been given by Mr. Assheton Smith, and other gentlemen well acquainted with the coast, are entitled to consideration. The holding ground towards the east end of the bay is stated by Lieutenant Sheringham, confirmed by Commander Tudor and other evidence, to be good (sand over clay). There is good granite in a cliff about two miles to the eastward of the harbour, and other stone equally convenient. The harbour may be said to extend from Porth-dyn-llaen Point on the west to Point Nevin on the east, this length being one mile and a quarter; the deep water and shelter are near the "Rock," which is a high narrow promontory or tongue, protruding about three quarters of a mile from the line of the shore, and forming a natural breakwater on the west, while the east side of Caernarvon Bay, distant about four or five leagues, affords some shelter from easterly winds, and confines within a narrow compass the fetch of the seas in that direction. Excepting with gales between north-north-west and north-east, there is shelter in the harbour for vessels of light burden, but the part so sheltered is very limited, being only close under the Rock, where the depth is small. For some distance to the eastward the shore is a long slope of clay or sand, from which there is a better chance of vessels that may be driven ashore being got off without being wrecked or seriously damaged, than at Holyhead, where rock prevails. That the northerly seas are much spent upon the long sloping sandy shore is proved by some dwellings being erected between the sand-hills (the foot of which is washed by extreme tides) and the water; a rough wall in front is their only protection, although their floors are but very few feet above high water, and some of these, with their doors facing the north, have stood unhurt for many years.

In its present state there is nothing to recommend Porth-dyn-llaen as a station for packets. Everything would have to be done; and it cannot be denied that the elevation of the surrounding sand-hills, which is 80 to 100 feet above high water, close to the sea, would cause considerable labour and expense to make convenient buildings, approaches, and communications. An example of this is given in the level at which Mr. Vignoles and Mr. Purdon, the engineers, have proposed to terminate the Porth-dyn-llaen railway near the point, being 70 to 80 feet above the level of the sea at high water. This may be lowered, but the inclination would be increased.

Your instructions to me are, to prepare plans for a harbour, for a packet station, and for a refuge harbour at Porth-dyn-llaen, as well as at Holyhead. I have done so, and by enlarging Lieut. Sheringham's chart, have to present a design for a pier and breakwater at Porth-dyn-llaen, drawn to the same scale as that for Holyhead.

Firstly—For a packet station, the design proposes to form a pier from the east angle of Porth-dyn-llaen Point to Carreg-y-chwislan (lettered A B on design No. 2), a length of about 300 yards, in an east by south direction, which is terminated by a return jetty upon Carreg-y-chwislan. This would give good length for steamers; the depth inside it is ample. The width of the quay or pier, exclusive of parapet, is shown to be 50 feet. I have supposed a quay wall at the west end of the pier to be requisite for the purpose of giving between it and the Rock a site for buildings, and other conveniences necessary in connection with the packets. This is drawn to go southward from the west end of the harbour wall, at A on the plan, and to extend to D, a length of nearly 200 yards. The amount of the works I have described to form this packet-station is estimated at £120,000

Secondly—A harbour of refuge is supposed to be obtained by forming a sloping breakwater (from B to C on the plan) 600 yards in continuation of the pier. The area sheltered from the worst winds, and of which no part would have less than 12 feet water at low water, is about 100 acres, which, from the apparent facility of procuring stone,* might be executed for about 90,000

* I have not supposed any stone to be taken from the Porth-dyn-llaen Point, which it would be injudicious to do.

Thus the engineering works for the packet-harbour and refuge-harbour would be . . . . £210,000 exclusive of all other buildings and accommodation, the expense of which would raise the total cost above that for all the works I have designed for Holyhead, and then Porth-dyn-llaen would be more contracted in quay room, and inferior in other conveniences, but would have a larger deep-water harbour.

To detail the advantages and disadvantages of Porth-dyn-llaen for a packet station would be, as in the case of Holyhead, to repeat a great part of the observations of others. I do not pretend to criticise the nautical opinions, but I beg to remark that Sir James Gordon's and Captain Beechey's illustrations and inferences on the generally injurious effect of the tides in making the crossing from Porth-dyn-llaen as compared with Holyhead, are very plain, and to me convincing. There are cases when they will not apply, and when Porth-dyn-llaen would have the advantage, as in the case of starting from Holyhead at the first of a flood-tide during heavy south-westerly, which are the prevailing winds, when the steamer must stem the tide and be nearly in the teeth of the gale, while a packet leaving Porth-dyn-llaen at the same time might keep under the land out of the bay towards Bardsey, when the south-west would afterwards be a fair wind across the channel, and here the Porth-dyn-llaen passage would be the best; but the average cases, and the circumstances attending the passage in both directions being considered, I think the general conclusion, even without that most powerful of all arguments, experience, is decidedly in favour of Holyhead. Porth-dyn-llaen harbour being in Caernarvon Bay, must always be an objection from the great risk of not getting out to sea in a northerly gale in case of missing the harbour. The most zealous advocates of Porth-dyn-llaen would, I think, recommend keeping out of Caernarvon Bay, if possible, when the gale is northerly, particularly in thick weather, unless he were sure of making a harbour.

Mr. A. Smith recommended a floating light at the mouth of Caernarvon Bay, as Bardsey light is 14 miles distant on the south, and the South Stack 18 miles on the north, but even then the passage would be much worse lighted than that to Holyhead, and there would be the liability to a floating light being driven from its position by severe storms, when it is most required.

The relative positions of Holyhead and Porth-dyn-llaen harbours, and the adjacent coast lighthouses, are shown on drawing No. 3. The advocates for Porth-dyn-llaen place in the fore-ground the objection that Holyhead is often in fog, and point to the excellent land-mark afforded by the "Rivals," and other high ground in the bay. The reply from the other side is, that there is deep water to the foot of the "Head," which is often clear when the summit is in a fog; that it is the land-mark which is of all others best known, which a seaman coming into the channel generally attempts to make; that the Rivals in Caernarvon Bay are not to be seen in foggy and thick weather until approaching them, when, if a mistake has been made, it is difficult to correct it; and that the Rivals, at the bottom of the bay, are by no means equal to the Head at the projecting point, as a land-mark.

That fogs are prevalent off Holyhead is proved by the expedients adopted. An occasional lower light is exhibited at the South Stack when the upper light is obscured, and in addition to the light at the pier, a gun, a bell, and other means are used for guiding the packets to the entrance of Holyhead harbour in thick weather. My conclusion is, that the top of the Head is as frequently, or even more frequently, in fog, than the top of the Rivals, but that the peculiar form and features of the South Stack in front of the Head gives Holyhead the advantage. And, on the whole, I think that Holyhead, by day and by night, is now better marked and beaconed than Porth-dyn-llaen can be.

Commander Tudor considers the uniform depth of soundings near Holyhead to be a practical difficulty which would not be experienced in making Porth-dyn-llaen, where the gradual decrease of depth would, he considers, always indicate the position, and, so far as soundings go, I take this to be correct, although the commanders of the steamers state that they have no difficulty in making Holyhead by sounding. Their great experience may have overcome the natural difficulty.

On referring to the objections to Holyhead, it may be noticed that they chiefly apply to the harbour as it is. Now, if the measures I have proposed would remedy these defects, which I think they would do, and render it nearly a perfect packet station and harbour of refuge, it is in this improved state that it should be compared with Porth-dyn-llaen in its improved state; for, in a national question of this kind, the true policy I take to be, to select what is capable of being made the best, and, if there has been an error in hitherto using Holyhead, to proceed no further, but at once to adopt Porth-dyn-llaen. After, however, doing the best in my power in planning for both places, and supposing the land facilities equal, I have been unable to discover anything like sufficient grounds for preferring improved Porth-dyn-llaen to improved Holyhead for a packet station. I should say this if the sea distance were equal, which is not the case, Holyhead being nearer by six geographical or seven statute miles. Sir J. Gordon and Capt. Beechey state the virtual difference in making the passage, owing to the influence of the tides and to clear the Kish Sand, as several miles greater than the actual difference; and on the average of cases the fact will, as I have said before, be so.

If, then, Holyhead be the better station, independently of the town, the pier, the dock, the Government yard, and the present land communication,—all these come in to add to the weight of the arguments in its favour,—I do not think it possible to have at Porth-dyn-llaen so convenient a site for a dock-yard establishment, as I have them upon the plan on the west side of the proposed new harbour at Holyhead. For these purposes also, the nearer distance of Holyhead to Liverpool by sea, for the conveyance of materials, is a consideration.

Notwithstanding all this, a harbour at Porth-dyn-llaen, on the plan I have proposed, would be found very useful as a harbour of refuge for wind-bound vessels or ships in distress, driven into or near to Caernarvon Bay, or going to Caernarvon, or to the Menai Straits for cargo, and waiting to cross the bar. The fact of a vessel being in greater danger when in Caernarvon Bay than when off Holyhead, makes a harbour of refuge for ships that may be embayed the more necessary. Such retreats for trading vessels (if refuge be the only object) are not, however, so much desired by the shipowners as might, at first sight, be expected; their great object, if the vessel be insured, being to make a quick voyage, and therefore they prefer their vessels being kept out at sea, even at a little risk. I beg to refer to Lieutenant Sheringham's report of 1838, on the subject of a refuge harbour here. If the harbour were intended for this purpose only, a considerable saving might be made in the cost of construction, as a great portion, if not the whole, of the upright wall might be dispensed with.

I do not apprehend much danger of sand from Caernarvon Bar finding its way to Porth-dyn-llaen, and silting up the harbour, the distance being considerable (12 miles), and the direction of the tidal current from the straits out of the bay being so far to the northward of Porth-dyn-llaen. The foot of the sand-hills would have to be secured, as Sir James Gordon and Captain Beechey have proposed: this could be done at a small expense, so that little or no sand would wash from them in future; but as the fine sand which now covers nearly the whole of the bay must be stirred up by heavy seas, and driven from the cliffs and the shore by strong winds, a portion of it will get into the harbour, and tend to shoal it, though not to any considerable extent. If the idea of a packet station be abandoned, there would be less occasion for stopping the tidal current by connecting the breakwater with the mainland. In this case, however, the design would require consideration.

From this large body of evidence it appears that all the naval surveyors and civil engineers, who have hitherto been instructed by the government to report upon the relative advantages of Holyhead and Port Dynllaen, give the preference to the former, and it is therefore probable that it will continue to be the packet station. The improvement of the harbour is the next consideration, but at present we cannot enter upon that important subject. We do not, however, quite understand why Mr. Walker should have been instructed by the Admiralty to prepare plans for both situations, since, from the terms of his instructions, he was to determine which was the most eligible, the Lords Commissioners intending, we suppose, to follow his opinion if found to corroborate that of those gentle-

men who had been previously employed upon the same subject. The question is one of momentous importance to Ireland—a country which, although an integral portion of the British empire, is not yet conscious of the benefits that can be conferred upon her by engineering science judiciously employed, but the influence of which will, we trust, be felt at no very distant period. This is perhaps the first step, and it is one in which the credit of the profession is scarcely less interested than the national advantages that will result from the execution of a judiciously designed plan.

REVIEWS.

An Account of some Remarkable Applications of the Electric Fluid to the Useful Arts by Mr. Alexander Bain. By John Finlaison, Esq. London: Chapman and Hall. 1843.

In the quiet walks of science, where men are engaged in studying the operations of nature, and investigating the influence of physical agents, one might expect to find a spot free from the overreaching spirit of the age. Those who have frequented these paths with such bright hopes have been disappointed. Rank and wealth have here their influence as well as in the busy scenes of life, and avaricious spirits, whether for money or honour, disguise themselves under the garb of scientific inquiry. There are here parties and cliques—men marked for honour—men marked for sacrifice; and we may assert without much fear of contradiction, that a strong, investigating mind, and successful research, will not, without the patronage of a party, obtain for any man scientific celebrity. The book before us is a lamentable proof, if any were required, of the truth of these statements. This we say without expressing or insinuating an opinion upon the claims of Mr. Bain to inventions appropriated by Professor Wheatstone, but every page devoted to the discussion is a commentary upon the fact, that money is required as well as mind to make a man of science.

The object of this book is to claim for Mr. Alexander Bain, a young man without patronage, but possessing great mechanical skill and powers of research, the invention of the Electric Telegraph and Clock. We do not feel ourselves called upon to express an opinion upon the question in dispute, but we recommend the work itself to the perusal of our readers. It is not simply a controversial essay, but contains much valuable information, independent of the question of priority of invention, which will fully repay the reader. Mr. Finlaison, in the performance of what he considers his duty to his friend, has expressed himself in the least possible offensive manner to those whom he is called upon to oppose, and has at the same time communicated to his readers an amount of information rarely to be found in controversial papers.

Weale's Quarterly Papers on Engineering. Part 1, 1843.

Mr. Weale has long enjoyed the reputation of being one of the most enterprising publishers of the age, a character which he has undoubtedly earned by the issue of numerous well illustrated volumes connected with Engineering and the Fine Arts. This new enterprise will we hope be successful, for, although it is strictly a professional periodical, we are convinced, that every publication calculated to increase the knowledge of professional men is the means of developing fresh inquiries, and of promoting the interests of the community at large. The practical scientific knowledge which constitutes a sound and judicious engineer is not confined, as some persons believe, to the few men who have been successful in their enterprises, and have obtained a large practice. It is more commonly possessed by the members of the profession than is imagined; or at least so sound a foundation has been generally laid, that nothing more than examples and practice are required, to give them individually the superiority which is claimed for the Profession itself in this country. Engineering science is now in such a state, that the gossip which a few years since satisfied the readers of an engineering journal, is not only insufficient to maintain a sale, but is also received with little less than contempt. Mr. Weale has therefore wisely adopted the plan of publishing papers complete in themselves, and of taking a sufficiently extensive investigation of the subjects on which they treat to make them really valuable as papers of reference.

The first Part of this Periodical contains five papers, two of which are memoirs, with sketches of the professional career, of James Brindley and William Chapman. The life of the former was one of great professional activity, but unfortunately his limited education produced a real aversion to literary composition, and an affected contempt of it, which, however convenient as an excuse for men of less intellect but of greater pretensions in our own day, must be considered as a defect in his professional character. His works remain, and they will long do so, as a record of his skill and indomitable perseverance, and from them his biographers must obtain his history. But how valuable to the world would have been the statement of his opinions anterior to the commencement of that series of noble canals in which he was engaged,—of the difficulties with which he had to contend, and the manner in which they were overcome. His experience may be said to have been almost lost for want of such records. We need not look back to the dark history of Egypt for an instance of the communication of scientific knowledge by oral tradition, for even in the eighteenth century, in our own country, large public works, involving extensive scientific inquiries, have been executed with scarcely a record of their progress.

Mr. Hughes has felt the difficulty of writing a Life of Brindley, and has been necessarily compelled to confine himself to a description of the various works in which he was engaged, so that the paper might be almost as well called a Description of the Bridgewater canals. His sketch, however, of the professional character of Brindley, brings the man with all his remarkable self-reliance fully before the reader, and we may quote it as a fair specimen of the style in which the memoir is written; though without pledging ourselves to all the opinions the author has expressed.

PROFESSIONAL CHARACTER OF BRINDLEY.

In taking a hasty retrospect of Brindley's engineering career, it is important to remember that all the works he projected, planned, and executed, are comprised within a period of twelve years, and by far the greater part of them within the last seven years of his life. It is amazing to reflect that the man who had to struggle, without precedent or experience to guide him, with all the difficulties which attended the early history of canals, should himself have effected and originated so much. There can be no doubt that he possessed an intellect of the highest order, that his views were most comprehensive, and his inventive faculties extremely fertile. Brindley was wholly without education, and it has even been asserted that he was unable to read and write, the utmost extent of his capacity in the latter accomplishment extending no further than that of signing his name. This, however, has been disputed, as before mentioned, on the authority of his brother-in-law, who stated that he could both read and write, though he was a poor scribe. However this may be, it is certain that he was quite ignorant in the vulgar sense of the word Education, and perfectly unacquainted with the literature of his own or any other country. It may be a bold assertion, and yet I believe it to be one with strong presumptions in its favour, that Brindley's want of education was alike fortunate for himself, for the world, and for posterity. There was no lack of scholars in his day more than in our own; nay, the literary coxcomb had then a more flourishing soil in which to vegetate.

But where were the Brindleys amongst these scholars; where were the men capable of the same original and comprehensive views, the same bold unprecedented expedients and experiments upon matter and the forces of nature, which the illiterate Derbyshire plough-boy dared to entertain and to undertake? If we range the annals of the whole world, and include within our survey even those examples in sacred history where divinely appointed ministers were raised to work out great designs, we shall find no instance more remarkable, nor one which more completely violates the ordinary expectations and probabilities of mankind, than this in which the uneducated millwright of a country village became the instrument of improving beyond the bounds of sober belief the condition of a great nation, and of increasing to an incredible amount her wealth and resources. But it may be asked, Why would Brindley have been less fit or less likely to accomplish all he did, if at the same time he had been educated? The answer to this is, that a mind like Brindley's would have lost much of its force, originality, and boldness, if it had been tied down by the rules of science, his attention diverted by the elegancies of literature, or his energy diluted by imbibing too much from the opinions of others. Alone he stood, alone he struggled, and alone he was proof against all the assaults of men who branded him as a madman, an enthusiast, and a person not to be trusted. Who dare assert, if Brindley could himself have wielded the weapons of paper warfare, and himself have sounded the note of eloquent declamation, that he might not have been beguiled to waste his strength and talents in the most inglorious of combats, and have applied those energies to refute upon paper that which he did most amply refute under the canopy of the open heaven, upon the broad face of creation, upon the waters, and upon the earth? Who would exchange the career of Brindley for that of the noiseless bookworm, the blustering pedagogue, or the vaunting orator? Brindley has become himself a subject for contemplation instead of a mere medium through which men look towards something greater; a topic to arrest and command attention, not the mere instrument to point out something else which is worthy of such attention; a being whom men regard with wonder and admiration for his own deeds and for his own sake, not for the expression of borrowed sentiments, however enthusiastically conceived or loftily delivered. Let no one, therefore, regret that Brindley was uneducated in the learning of books and of the schools. He was a true disciple of nature. In the language of creation he was deeply read, and I question whether he who could imagine and execute such noble projects may not with justice be called one of the most highly educated men whom the world has ever produced. It was fortunate for Brindley that the vigour of his mind was allowed to employ itself in carrying into effect his great designs, rather than in attaining the art of communicating those designs to others, who would perhaps have passed them by unheeded till long after he had ceased to live. It has happened, and in our own times too, that a master spirit not inferior to Brindley, like him a child of nature, like him at first uneducated and of low degree, and with an intellect teeming with noble and lofty enterprise, has mastered all the difficulties of early neglect and abject poverty of birth, and taught himself the art of discoursing by his pen in strains of learned and most magically pleasing eloquence. If the reader would know with what success he thus wrote, the answer is, that although he continued the slave of his ever active intellect, and of his urgent pecuniary necessities, and wrote up to the very hour of his death, yet he died in penniless misery. I dare affirm, and there are some in the profession of engineers who know the man I mean, and who will bear me out in this, that if the services of this individual had been purchased by the government of any country in the world, and his unmatched abilities and profound acquaintance with nature had been allowed free exercise, he would have raised that country to a higher pitch of greatness than any statesman or legislator who has ever been entrusted with the fortunes of a nation.

When I contrast the fate of this equally great genius with that of Brindley, I cannot help repeating, that ignorance of books was probably a fortunate circumstance in his case; for if a mind like his had become accessible to the charms of literature and science, we might have had volumes which his contemporaries would have ridiculed and trampled upon, which posterity might, perhaps, have cherished, or perhaps not; but in that case we should certainly not have had to regard Brindley as the boldest leader in engineering enterprise, and the most successful and talented of all those who have laboured in the same honourable path. The great difference between Brindley's era and our own, must not, however, be forgotten. The literature of most European countries abounds with very valuable records of engineering works, and an acquaintance with these works is absolutely necessary to every one who would practise with credit and success. The modern engineer is enabled, by means of book education, to lay in a vast stock of experience, and to make himself master of much valuable scientific knowledge. In Brindley's day it was far otherwise; for there were few books which could have taught him that which he stood in need of, and education would only have given him weapons with which to oppose and foil his scribbling assailants. He was better without such weapons, for as it was, the shafts of his opponents fell harmless upon him; he who could not or would not read must have been impenetrable alike to the ridicule and arguments of those who dealt only in wordy warfare; and so he pursued the unbroken tenor of his way, conscious and confident of his own powers, little affected, either for good or evil, by the machinations of his contemporaries.

The materials for a Life of Chapman are ample, and we doubt whether they have been so fully employed by the author, in this volume, as they might have been; but it is an interesting essay, and a valuable guide to the student. The article on the dredging machine settles the question of the priority of invention. The other papers are on varieties of construction in the steam-engine, and are useful. The illustrations are ample and well executed, and the work will recommend itself to every professional reader.

Weale's Quarterly Papers on Architecture. Part 1, 1843.

This work is a Companion to the Quarterly Papers on Engineering. The principal, if not the only, communication that will attract much attention is an Essay by Mr. Moore—"On those powers of the mind which have reference to Architectural Study and Design." The Greenwich Union Poorhouse, by Mr. Brown, illustrated by four plans and an isometrical view, has little or no interest to the profession in the present day. So many of these edifices have been erected during the last few years that great improvements in construction and design, if not in arrangement, have been introduced. The life of William Vitruvius Morrison, by his brother, is an interesting tribute to the memory of this extraordinary man, and a valuable addition to professional biography. The specimens of painted glass from All Saints' and St. Martin's, York, are beautifully executed, but not more interesting to the architectural antiquary than the doors selected from some of the primitive churches of Norway. The illustrations are all that can be desired, and this is not an unimportant recommendation to the architect; but the only literary communication of importance is the essay already referred to, which we shall take another opportunity of examining.

RESTORATION OF TRENTHAM CHURCH, STAFFORDSHIRE.

Trentham Church, like many of our most ancient churches, forms an appurtenance to the mansion connected with the domain on which it is situated. Trentham Hall has been the family seat of the Levesons, and through them of the Gowers, upwards of three centuries. The present duke, soon after succeeding to the estates and titles of his forefathers, determined to repair and improve the family mansion, and calling in the aid of Mr. Barry (the architect who has so much distinguished himself at the new Houses of Parliament), his grace has, at an immense expense, converted a very modest and ordinary-looking mansion into a splendid Italian palace, and surrounded it with terraces, walks, and gardens, ornamented with pavilions, fountains, and statues.

The improvements connected with the Hall being nearly completed, his grace, with that munificence which has always distinguished his family, resolved that the parish church, which, like too many others, had been as much disfigured by the hands of ignorant conservators, as dilapidated by the lapse of time, should be thoroughly restored and repaired at his own cost. Mr. Barry, being intrusted with the work, evinced that true taste which ever distinguishes genius. He did not attempt to invent any thing new, but merely to restore that which was worthy, discarding the excrescences which had from time to time crept in. The consequence is, that Trentham Church is now a complete chronicle of the various styles of church architecture which have prevailed in England for the last 800 years: indeed, it is upon record that a church has existed at Trentham more than 1200 years. In the nave we have the original Norman columns, with their quaint caps and lofty pointed arches, the porch being a specimen of early English style, while the windows evidently belong to the later and more decorated or perpendicular style. And again, within the church, the oak screens, around the chapels and

across the choir, belong to the later years of the Elizabethan compositions, immediately preceding the total downfall of all notions of fitness or propriety in architecture, when even the glorious examples of Sir Christopher Wren and Inigo Jones served only as landmarks to the sinking art.

To make even a tolerable design out of such incongruous mixtures must have been a task of no small difficulty. How well the architect has succeeded, let the many approving opinions which have been passed upon it testify; while the introduction of several judicious alterations has tended to the improvement of the whole, and has contributed to render the general effect pleasing and harmonious. Among these improvements may be mentioned the extension of the nave both at the east and west ends, and the introduction of ornamental glazing, slightly combined with stained glass.

The floors of the aisles, choir, and communion, are paved with the new encaustic tiles, from Messrs. Minton's manufactory, at Stoke-upon-Trent, laid in various devices, and relieved with plain black borders, the whole having a very excellent effect. The parishioners, in order to testify their gratitude and respect to the noble duke, have subscribed for the expense of a new font, and his grace has kindly accepted the offer.—*North Staffordshire Mercury.*

THE BRITISH MUSEUM.

It is strange in these days, when all classes of men submissively bow to public opinion, from the ministers of the crown to the petifogging secretary of a loan society, that any individual receiving his emolument from the national purse should in contemptuous silence resist its authority. Sir Robert Smirke cannot be ignorant that the profession which he once led, and of which he is still a member, is anxious to know what degree of honour or discredit he is about to add to its English character; and that the public is not less solicitous to avoid the mortification of paying for that which may afterwards be viewed with disgust, and be considered a disgrace. It is surely not unreasonable that, with so many failures before them, both the profession and the public should entertain some fear that another opportunity of adding a tasteful building to the metropolis may be lost; and Sir Robert Smirke has no right to complain, if this fear should now be expressed in terms not so complimentary to his genius as he has been accustomed to hear. If we use an uncourteous term towards him, it is not because we would necessarily wound a mind, which, if warmed with but one single ray of genius, must be sensible of the reflection of a shadow upon its brightness, but because he is acting in a manner which may be construed into a resistance of the authority of public opinion, and a contemptuous assumption of a superiority in taste and skill, for which no one in the present day is willing to give him credit. The accumulation of a large fortune in the practice of a profession does not give its possessor the right to believe that his skill exceeds that of his contemporaries in the same proportion as his wealth. A man may easily form a very erroneous comparative estimate of his capacity, and especially when fortune aids industry without the assistance of genius, and if such be the case with Sir Robert Smirke, as his moody silence seems to indicate, it is desirable that he should know the estimation in which he his held by his professional brethren.

No one acquainted with the public buildings of this country would select those of Sir Robert as even fair specimens of the state of architecture in the present day. Smirke's merit has been that of copying more accurately than his predecessors. Imagination is a quality of mind of which he has given no evidence in any of his works. Correctness in his hands has become tameness, and anxiety for authority has produced servility. The sameness of style in all his elevations is positively distressing. But still he has had a beneficial influence upon architecture in his day, and, compared with the majority of the works of those who immediately preceded him, his designs have merit—not so if compared with the productions of some architects who have recently risen into public estimation. If we may suppose him conscious of this, it will sufficiently account for his apparent determination not to publish his design for the façade of the British Museum. This is the most charitable conclusion we can form, for we must otherwise suppose that he believes himself the only authority, and above criticism, in which case, for his own illumination, we should be induced to examine his productions, and to ascertain his real position among British architects.

PAPERS READ BEFORE THE INSTITUTION OF CIVIL ENGINEERS.

On the Supply of Water to the City of Glasgow. By D. Mackain, M. Inst. C.E.

This paper contains a history of the progressive increase of the Water-works of Glasgow, caused by the rapid extension of the city and its manufactories, derived from the documents in the archives of the Water Company, to which the author is the engineer.

The statement commences from the year 1755, at which time Mr. John Gibson, in his History of the City of Glasgow, expressed a desire for several improvements, among which he particularly mentioned a better supply of water, as although the population amounted to 23,000 persons, the water used by the inhabitants was drawn from the Clyde, from the several streams running through or skirting the city, and from wells in the streets; the water from the latter was unfit for domestic purposes, and the manufactories gradually extending on the sides of the burns polluted their waters, and thus rendered a better general supply absolutely necessary. The various plans proposed in the year 1780 and subsequently are then detailed, and as an instance of the low estimate then formed of the quantity of water required for a community amounting to about 43,000 persons, it is said that the produce of a spring at Whitehill, which it was then proposed to convey to the city for its entire supply, is now found inadequate for the wants of a house of refuge for juvenile delinquents lately erected near it.

In describing the project of Mr. Henry Bell for bringing water by a canal from the Falls of the Clyde, his reasons are given for rejecting the use of steam-engines. "These engines," he says, "are not only in themselves objectionable, in so far as they will be hurtful to the value of surrounding property, and a general nuisance to that part of the city or neighbourhood where they are erected; but the consumption of coals which will thereby be occasioned will tend in no small degree to heighten the price of that fuel."

An account is given of the speculation of Mr. Harley, who erected pumps at Willow Bank, and forced the water through pipes into a reservoir in Upper Nile Street, whence it was carted through the town, its sale producing a revenue of about £4000 per annum.

At length a water company was formed, and Mr. Telford was requested to report upon the proposed plans, all of which he found objectionable, and recommended that steam-engines should be placed on the banks of the Clyde, at a spot about two miles up the river, with the necessary reservoirs, filters, &c., and that the water should be forced by pumps into the city. He estimated that the quantity of water required for a population of 80,000 persons would be about 500 gallons per minute; that, including manufactories, the renters would be about equal to 6000 families; and that the average rent upon that number would be £2 per family, which would produce £12,000 per annum. Acting upon this report, in the year 1806 the company ordered from Messrs. Boulton and Watt two engines with cylinders of 36 inches diameter, and laid pipes of 14 inches diameter to a reservoir on the spot then called the Gallow Muir: from this small commencement sprung the present extensive works, whose gradual increase is carefully traced in the paper until the enumeration of its actual position in 1842, when the population of the city exceeded 300,000 persons, and the annual income was about £30,500, making the average payment about nine shillings per annum for each family. The works had increased until they consisted of thirteen steam-engines, of various powers, with their filters, reservoirs, &c., an accurate account of which is promised in a future communication.

In this history many statistical details are given, obtained from the archives of the company; and the difficulties encountered by the engineers who preceded the author in the management of the works are clearly described.

The details of the various oppositions from local interests, the several Acts of Parliament, the fluctuation of the mercantile value of the shares, the history of the Cranston Hill Water-works, formed by a rival company, with whom for a time a ruinous competition existed, and whose works it became necessary to purchase, are given at length. The paper then describes the natural filter for the water, which was taken advantage of, by driving tunnels along the borders of the peninsula round which the Clyde sweeps in the form of a horse-shoe. This spot being composed of sand and gravel would, it was argued, form a filter, whence the water could be pumped up and conveyed across the river into the city. Many plans were designed for thus carrying the water; that which was adopted was suggested by Mr. Watt: he proposed the use of cast-iron pipes, fitted, where necessary, with revolving ball and socket joints, which he then first introduced, and of which he sent a wooden model to the company, which model was now presented to them by the Institution of Civil Engineers. These pipes adapted themselves to the form of the bed of the river, and the plan was perfectly successful.

Mr. Telford's experiments upon stone pipes are mentioned, and some results are given. A stone from Rutherglen White quarry, 4 feet 9 inches long, 18½ inches square, with a bore in it 9¼ inches diameter, when subjected to a pressure of a column of water from 60 to 80 feet in height, split in the direction of the natural bed. Another stone from the same quarry, 5 feet 2 inches long, 13 inches square, with a bore of 4½ inches diameter in it, did not emit any water until the pressure amounted to 100 feet head; after that it discharged water freely, and split when the column a little exceeded 300 feet. A Portland stone, 4 feet 6 inches long, 12 inches diameter, with a bore of 6 inches diameter in it, did not emit any water, nor was there any symptom of fracture under a pressure of 350 feet. Other stone pipes were also experimented upon with such various results, that Mr. Telford arrived at the conclusion, that they could not be relied upon, and accordingly recommended iron pipes.

The paper is illustrated by a large map of the city of Glasgow, upon which is shown, by different tints, the houses which existed when the water-works were commenced, the ranges of distribution, and the extent of the district for which the company is bound by Act of Parlament to supply water for certain periods during each day.

Mr. Simpson said that he was well acquainted with the works which had been described, as he had repeatedly visited them professionally; there were many points of interest attached to them, and the engineering operations were of considerable magnitude and importance. The late Mr. Watt suggested the idea of using the sandy peninsula on the opposite side of the river Clyde to the present works of the Glasgow company at Dalmarnock, as a natural filter, and it succeeded admirably, until the immoderate quantity of water was delivered to the city during the competition with the Cranston Hill Water Company. Of this spot, and the tunnels and wells in it, he presented a tracing. When he was at the works in the year 1833, Mr. Alexander Anderson, the then resident engineer, had been pumping water on to the peninsula for many months, and the deficiency of the natural filters (nearly half the supply at the time) was made up by that means; at first the pumps were worked by rocking shafts connected to the engines across the river; afterwards pumps were erected close to the engines, and the water conveyed across the river through pipes. A very large portion of the supply to the inhabitants was drawn from the mains, without the intervention of cisterns, and a great deal of the water was thus wasted. The filter recommended by Mr. Telford was composed of a series of cells fillled with sand, the water passing through them in succession; this filter was not effective during floods or when the water of the Clyde held in suspension the colouring matter from the peat-mosses; after passing through the first cell little more was accomplished, and the water continued discoloured. Mr. Simpson had, however, seen the Clyde water filtered until it was perfectly bright, by conducting the process very slowly, the rate of motion not exceeding half an inch per hour through the medium—precipitation on the sand evidently took place; he had in some instances accelerated the precipitation by previous admixture of alumina or pipeclay and other materials, and had succeeded in throwing down the colouring matter, so that the filters produced perfectly pellucid water. In a filtering bed properly arranged, the impurities were arrested at and near the planes of ingress,—great extents of medium effected little in addition. In some filters which had been worked for nearly sixteen years, it had not been found necessary during that period to change the entire mass of materials. The natural filters of the Glasgow company had been injuriously affected by depressing the water in the wells, thereby increasing the pressure of the water on the bed and the foreshores of the river, and thus bringing the particles of the medium into too close contact, and forcing obstructions between them. The Glasgow Water-works was an example of the employment of the largest steam-engine power for water-works purposes in Britain; he believed that at one period the engines at the works were equal to nearly 700 horse power. During the erection, in 1829, of the second pair of engines, with cylinders of 54 inches diameter, many difficulties were encountered; in the Vale of the Clyde, large quantities of mud almost in a fluid state lie intermixed with the strata. In sinking the wells for these engines the mud was met with much nearer the surface than was anticipated, and when tapped, it rose up like a fountain in the bottom of the well; the pumps were, in consequence, fixed at a higher level than was originally designed. Mr. Crichton, of Soho, was of opinion that the alteration of 4 feet 5 inches in the level of the pumps was immaterial; he probably did not calculate upon the water sinking in the filter-wells when the increased pumping power was applied. Mr. John Gibb, of Aberdeen, who was consulted about the foundation, bored to 30 feet lower than the bottom of the new well, and found that the ground became weaker as the depth increased, so that any attempt to sink the well to the depth required would be very hazardous. He therefore advised the enlargement of the surface of the building under the whole superstructure, with due provision for the weights and strains in the arrangements,—that a strong platform should be constructed of Memel logs and planking for the foundation, and the spaces between the timber to be filled in with masonry flushed in and grouted: this plan was adopted, and proved successful as a foundation; but the depth was insufficient, and the working barrels of the pumps were obliged to be fixed so much above the level of the filters, that they ceased to fill when the water in the tunnels was depressed 22 feet below the tops of the pumps. This was a serious disappointment to the company, for whenever the water in the river was low, a corresponding depression occurred in the wells of the filters; and in general, for many hours daily, these two engines only raised as much water as one would have pumped, if the working barrels had been fixed at the proper level. The suction-pipes were inclined towards the filter wells, and the pumps were distant from them about 110 yards: this, Mr. Simpson considered, was comparatively of little importance, as he had worked pumps with horizontal suction-pipes 500 yards in length.

Mr. Hawkins recommended slow filtering, without pressure: some years since he had been engaged in refining sugar by Howard's process, by which the syrup was applied to the filter under a column of 20 feet in height; out of a certain quantity, 300 gallons were returned unfiltered, and by the time 60 gallons had been clarified, the filter was choked. He reduced the column to 2 feet, and out of the same quantity 6 gallons alone were returned, while 300 gallons were clearly filtered; this, and numerous other cases, had convinced him that pressure was injurious to filtration.

Mr. Braithwaite believed, that although slow filtration was generally preferable, yet that the velocity must depend upon the quality as well as the quantity of matter held in suspension; this consideration would also regulate the time during which the filter could be worked without cleansing.

Mr. Hawkins found practically, that half an inch in depth was the utmost that was required to be removed from the surface of the filtering medium when it was cleaned and renewed.

Mr. Simpson said, that in order to filter properly, there should be extensive reservoirs, where all the grosser particles could subside or be arrested previously to arriving at the filtering medium; with due attention to this point he had seen filtering beds worked for sixty-seven days consecutively without requiring to be cleansed.

Description of a cast-iron Reservoir erected at Garnet Hill by the Glasgow Water-works Company. By D. Mackain, M. Inst. C. E.

A considerable extension of the city of Glasgow is now taking place to the north-west of the old town upon an elevation of upwards of 100 feet above the river; the water works, which are situated to the east of the city are already upwards of 4 miles distant from the extreme point of delivery, which is almost daily becoming more remote, and the cost of the supply of water is consequently increased. These circumstances rendered necessary the establishment of a new reservoir, which should be sufficiently high and capacious to command and to supply the district. The ground which was obtained for this purpose was on the declivity of Garnet Hill, and had a fall of 20 feet in 90 feet extent. It was necessary to keep the bottom up as high as possible, and yet not to contract the space by thick walls, and to erect such a building as should not be offensive to the neighbourhood; these considerations induced the author to recommend the use of iron plates for the reservoir, which should be masked by a screen of masonry designed by Mr. James Smith, architect of Glasgow.

The construction is thus described. A bearing wall of 4 feet 6 inches in thickness was carried up from the foundation all round to within 1 foot of the floor of the reservoir. A division wall was built across the centre to carry the partition for dividing the reservoir into two parts. The space within these walls was filled in with broken stones, over which was a layer of clay, and then a layer of sand, upon which was placed a flooring of Arbroath pavement well jointed with cement, and resting at the sides upon the flanches of the sole plates, which were bedded in a mixture of lime and Roman cement, in such proportions as afforded ample time for the adjustment to be completed. The lower tier of plates was 1 inch, and the upper tier $\frac{11}{16}$ inch in thickness. Their flanch joints were made secure by inserting between the faces a lead pipe ⅜ inch diameter, filled with lint-gasket soaked in red lead and tallow, in addition to which the whole was caulked with a composition of hot lime and linseed oil, which in a short time became very hard.

The reservoir is 123 feet long by 85 feet 6 inches wide, and 13 feet 2 inches in depth; it is entirely covered by a malleable iron roof supported upon cast iron pillars.

The paper is illustrated by two drawings and four lithographs, giving the dimensions of every part of the work, and by a specification of the mode of execution.

Mr. Simpson said that he had examined the reservoir very carefully, and could bear testimony of the excellent manner in which the work was done. The mode of construction was novel, and had succeeded perfectly, as no leakage had occurred since its erection, nor had any inconvenience arisen from the variations of temperature, or from the unequal depths of

water in the two compartments. He thought Mr. Mackain was entitled to much credit.

Coradino Tank in Malta.

A drawing of the Coradino Tank, erected in 1841-2, in the island of Malta, was presented by William Lamb Arrowsmith, Assoc. C. E. (Superintendent of Government Works at Malta.)

It was described as the largest modern covered tank in Europe; its cubic contents being 700,000 feet; and with its settling reservoir it would contain 15,000 tons of water; the roof was supported by rows of square pillars 15 feet in height. It was intended to form a part of the works for supplying the island with water, a description of which was promised to the Institution, to complete the paper on the supplies of water for cities, the first part of which has already been received.

Artesian Well at Grenelle, and Temperature of Water at Great Depths.

A letter was read from the late Sir John Robison, giving a short account of the Artesian Well at the Abattoir de Grenelle, Paris.

The Abattoir being at too high a level to obtain an adequate supply of water by the ordinary means, it was proposed, about eight years since, to sink an artesian well within the premises, which proposal having been agreed to, the execution of it was entrusted to Monsieur Mulot. The work having been perseveringly carried forward through many difficulties, the boring was terminated by the auger penetrating the water-bearing strata on the 26th February, 1841, when a sudden and violent rush of water occurred, overflowing at the surface of the ground.

As the boring progressed, tubes of rolled iron, and subsequently of copper, were inserted to support the sides, the first being 12¼ inches diameter, and the lowest about 6½ inches diameter, reaching to a depth of 1794½ English feet. The quantity of water thrown up while the bore remained in this state was about 880,000 imperial gallons per day, at a temperature of 82½° Fahrenheit; the expense incurred up to this time being upwards of £12,000 sterling.

Sir John examined the theoretical reasons which had been given for the contortion of the tubes, which had been attributed to the violent pulsations in the flowing water acting upon the outside of them, crushing them inwards; he objected to this reasoning as not being in accordance with the laws of hydrostatic pressure, and attributed it rather to mechanical causes arising from the force used in forcing the tubes down the hole, and even more to the violence they were subjected to in being withdrawn from it.

The letter was illustrated by a lithographic section of the well, which was presented by William Cubitt, Assoc. C. E.

Mr. Cubitt had recently visited the well, and found the water flowing with considerable force through an orifice in the vertical pipe about 8 feet beneath the level of the ground; the nozzle of the orifice, which was 10 inches diameter, was about half filled, and the stream was reported to be supplying about 2500 litres per minute, at a temperature of 82° Fahrenheit. The water was not clear; it deposited a considerable quantity of fine sand, and occasionally stones of about 2 inches cube were brought up. He was informed that the water had at one period ascended to between 70 and 90 feet higher than the ground.

Mr. Taylor observed, that the temperature of the water nearly coincided with that of the United Mines in Cornwall, which were 295 fathoms, or 1770 feet, deep. The highest temperature recorded there was, he believed, 96° Fahrenheit. It was well ascertained now, by the experiments of Mr. Fox, that the heat was not increased either by the decomposition of the pyrites, or the number of men and horses employed in the mines.

Mr. Enys said, that the experiments by Mr. Fox, as published in the report of the seventh meeting of the British Association, gave a temperature of 92° in the lode at a depth of 290 fathoms, where it was first reached in the cross-cut; but on proceeding along the same cross-cut, at ten fathoms from the lode, the temperature decreased to 86° 3′, and at 24 fathoms distant it was 85° 3′: this would give a close approximation to the temperature quoted by Mr. Cubitt.

Mr. Braithwaite inquired at what depth the temperature began to increase; landsprings were generally at about 52°, and he found the water in wells 600 feet deep usually at 53° or 54°. He had understood that the temperature increased 1° for every 65 feet after a certain depth.

Mr. Enys said, that Mr. Fox's experiments gave a ratio of increase of 1° of temperature in 48 feet, calculated from the surface. He thought that the close approximation of the temperature of the land springs, and the wells mentioned by Mr. Braithwaite, might be accounted for by the rapidity with which the water filtered through the strata of the London basin.

Mr. Taylor agreed that the heat of water was influenced by the nature of the strata; the Cornish miners, when they were taken to the North Welsh mines, were much inconvenienced by the coldness of the water in the latter, although the depths of the mines in both districts was nearly identical.

Mr. Braithwaite believed that his view of the temperature of wells would be corroborated by the coldness of the water in the new well at Southampton, which had now arrived at a very considerable depth, and he understood that the temperature of the water was about 54°.

Mr. Simpson said, that the well at Southampton had been sunk and bored to the depth of 1063 feet; the supply of water was not considerable, and he was not aware that any observations had been made as to the temperature. A well at Chichester had now arrived at the depth of 1013 feet, and was still being carried lower.

Mr. Sopwith contended for the accuracy of the investigations of Count Brenner on the temperature of two German mines, and of Messrs. Fox, Buddle, and others in England; the differences between the results obtained were so trifling as to induce confidence in the conclusion they had arrived at, which was, that after allowing for the radiation of heat at a certain distance from the surface, the temperature increased 1° for every 50 feet in depth. This law might not hold good in certain local basins, where from the nature of the strata the percolation of surface water was rapid, but in the extensive mining districts it certainly was correct.

Mr. Cubitt suggested that the close approximation of the temperature of the water in the well at Paris and that observed by Mr. Fox at the same depth in Cornwall, might arise in some measure from the large volume of water in the former, and the rapidity with which it arrived at the surface; whereas in the deep wells which had been mentioned, the water had probably been allowed to cool before the temperature had been ascertained.

Mr. Clarke corroborated the opinion entertained by Mr. Cubitt: in a well which he had sunk to the depth of 540 feet at St. Alban's, he obtained, by an apparatus constructed for the purpose, some water from the bottom of the well, and found it 4° hotter than that which was pumped up from the same well. At the bottom of a well at Messrs. Barclay's brewery, 367 feet deep, the water was hotter than at the water-level in the same well. Local causes frequently affected the temperature of water in wells; he had seen instances of the water being warmer at 60 and 70 feet deep than at 300 feet, but these cases would not influence the general law.

Mr. Vignoles considered the facts mentioned by Mr. Clarke to be very valuable, and as bearing out Mr. Cubitt's idea; there could be little doubt that if, by means of self-registering thermometers, the temperature of the water was ascertained, at the issue of the springs, at the bottom of deep wells which were not influenced by local causes, the result would prove in accordance with the observations of Fox and others. By the laws of the circulation of fluids the heavier water, which had been cooled at the surface, mingled with the lighter and warmer water as it rose; the sides of the well also tended to abstract the heat: therefore the temperature should be obtained at the greatest depth in order to make any correct experiment.

Mr. Braithwaite agreed in the influence of local circumstances: in a well at Cheshunt, at a depth of 40 feet, a sulphureous spring issued, the vapour of which almost killed the workmen; and when at last it was built out, the bricks continued so hot that the hand could scarcely be borne against them. Below that point very cold water was met with.

Description of the Water-pressure Engine at Freyberg, Saxony. By William Lewis Baker, Grad. Inst. C. E.

The machine described in this communication was designed by Herrn Brendel in 1823, and constructed in 1824, for draining the "Alte Mordgrube" mine, one of the largest silver mines in the neighbourhood of Freyberg, Saxony. This engine, which is fixed at a depth of 360 feet below the surface of the ground, has two single-acting cast-iron cylinders, each 18 inches in diameter, and 9 feet stroke, to the pistons of which are fixed strong timber piston rods, each attached at their upper ends, by a flat iron rod and chain, to the opposite segments of a horizontal working beam, thus connecting the pistons of the two cylinders, so that, when one is being moved upwards by the pressure of water underneath it, the other is depressed by the weight of all the pump-rods and other moving parts to which it is connected. The admission and eduction of water from the cylinders is regulated by slide valves worked by levers and tappets. The piston-rods give motion to the horizontal arms of two bell-crank levers, the diagonal arms of which move the main pump-rods, working forty-four pumps in two sets of twenty-two, each placed one above another, at an angle of 45° with the horizon, each dipping into the delivery cistern of the pump immediately below it; this is repeated downwards for the whole series; and thus the water is raised from the bottom of the mine to the point where it runs off by an adit. Each pump has a lift of 30ft. 4in. The duty performed by this engine is stated by Gerstner to be as 70 to 100. The author then gives a very minute account of the construction of the engine, illustrating the paper by three drawings giving the general arrangement and the detailed dimensions of all the working parts.

Mr. Taylor remarked that the water-pressure engine was of Hungarian origin; it was extensively used in Germany, and had latterly been

much improved in construction, particularly by abandoning the rude mode of placing a series of pumps over each other, as had been described in the paper. He believed that Smeaton erected the first engine of the kind in this country. Trevithick built one about forty years since, with cylinders of 30 inches diameter. Another was erected by Mr. Fairbairn, and since then, one had been built, under the direction of Mr. Darlington, with cylinders of 50 inches diameter, and 10 feet stroke, worked by a force of water of 22 fathoms, through a descending column of 30 inches diameter; the pumps worked by the engine were 42 inches in diameter, raising water from a depth of 22 fathoms; the usual speed of working was four strokes per minute, but he had seen it attain six strokes. The concussion produced by the closing of the valve at the end of the stroke was generally very prejudicial to these engines, but in that made by Mr. Darlington, it was diminished by allowing the large valve to close a short time before the stroke finished, and bringing the piston home with a small valve; by this means no noise was heard beyond that of the rush of the water, and the violent shocks were avoided.

Screws cut in Lathes.

Some specimens were exhibited of screws cut in lathes constructed by Messrs. Shanks and Co., of Johnstone, near Paisley. They were sent by the late Sir John Robison, who described the principal advantages of the arrangement of the lathe for cutting them, to consist in the cutters acting during the incursion as well as the excursion of the slide, and when forming long screws, in their being alternately stayed on the side opposite to the tool which was in action; that by these means good work could be produced with such dispatch as to reduce the cost of turned screw bolts as low as that of similar articles produced by screwing machines, which worked with dies acting by compression. A drawing of the lathe used in cutting the screws was presented with the specimens.

Mr. Field observed that the machine was ingenious and appeared to do the work well; but, as far as could be ascertained from the drawing, there was not any novelty in it. A similar machine made by the late Mr. Maudslay, had been in use in Maudslay and Field's manufactory for the last fifteen years. The screwing dies invented by Mr. Whitworth cut out the threads of screws as clearly as if done by a chasing tool, and entirely without compression.

Description of a Mode of obtaining the perfect Ventilation of Lamp-Burners. By James Faraday.

The paper commences by stating, that in consequence of the injury sustained by the books in the library of the Athenæum Club, and the complaints made by the members of the vitiated state of the air in the rooms, the attention of Professor Faraday was drawn to the subject, and that he suggested the trial of various plans for effecting the removal of the products of combustion, and for the ventilation of the lamp-burners.

The author then assumes, that all substances used for the purpose of illumination may be represented by oil and coal-gas; for although tallow and wax are also employed, yet as they cannot be burnt until they are rendered fluid like oil, they may, for all practical purposes, be classed with it.

Oil and gas both contain carbon and hydrogen, and it is by the combination of these elements with the oxygen of the air that light is evolved. The carbon produces carbonic acid, which is deleterious in its nature and oppressive in its action in closed apartments, and the hydrogen produces water. A pound of oil contains about 0·12 of a pound of hydrogen, 0·78 of carbon, and 0·1 of oxygen; when burnt it produces 1·06 of water, and 2·86 of carbonic acid, and the oxygen it takes from the atmosphere is equal to that contained in 13·27 cubic feet of air. A pound of London coal-gas contains on an average 0·3 of hydrogen, and 0·7 of carbon; it produces, when burnt, 2·7 of water, and 2·56 of carbonic acid gas, and consumes 4·26 cubic feet of oxygen, which is equal to the quantity contained in 19·3 cubic feet of air.

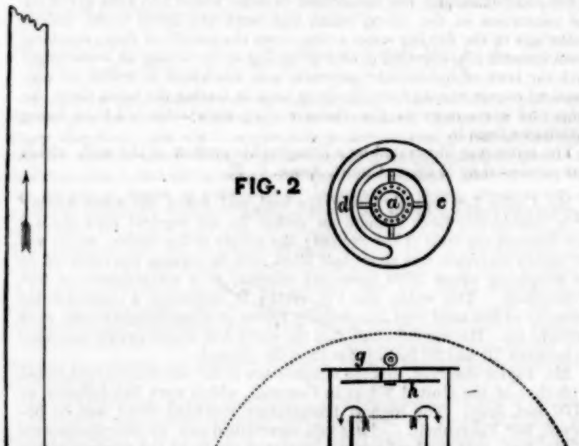
A pint of oil when burnt produces a pint and a quarter of water, and a pound of gas, more than two and a-half pounds of water; the increase of weight being due to the absorption of oxygen from the atmosphere, one part of hydrogen taking eight parts (by weight) of oxygen to form water. A London Argand gas lamp, in a closed shop window, will produce in four hours two pints and a half of water. A pound of oil also produces nearly three pounds of carbonic acid, and a pound of gas two and a-half pounds of carbonic acid. For every cubic foot of gas burnt, rather more than a cubic foot of carbonic acid is produced. As carbonic acid is a deadly poison, an atmosphere containing even one-tenth of it is fatal to animal life. The various accidents from lime and brick-kilns, brewers' vats, occasionally from the sinking of wells, and from the choke damp in coal mines, attest the danger contingent upon the presence of this substance. A man breathing in an atmosphere containing seven or eight parts of carbonic acid would suffer, not from any deficiency of oxygen, but from the deleterious action of the carbonic acid.

M. Leblanc has recently analyzed carefully the confined air of inhabited places, and concludes, that the proportion of carbonic acid gas in such places may be regarded as measuring with sufficient exactness the insalubrity of the air; that in the proportion of 1 part to 100 of air, ventilation is indispensable for the prevention of injury to the health; that the proportion of carbonic acid gas should not exceed a five-hundredth part, though it may extend without inconvenience to a two-hundredth part. If a room twelve feet square and twelve feet high, with the doors, windows, and fire-place closed, has a gas lamp burning in it, consuming five cubic feet of gas per hour, the light will produce sufficient carbonic acid, in rather more than three hours, to be in the proportion of 1 part to 100 of air, and, as M. Leblanc states, when in such condition the air is decidedly injurious to health: and even in one hour and a-half it will produce that portion of carbonic acid which he considers should never be exceeded.

The experiments which were made led to a modification of the ordinary mode of ventilating by ascension, and finding that there was sufficient draught in the main part of the metal chimney to allow of a descending current over the lamp, the tube, instead of going directly upwards, was made to turn short over the edge of the glass, to descend to the arm or bracket, to pass along it, and then ascend at the central part of the chandelier, or against the wall if applied to a single light. To this succeeded another form, which is very simple, and is in fact only a correct application of the principle of a descending draught to a lamp-burner.

The gas-light has its glass chimney as usual, but the glass-holder is so constructed as to sustain not merely the chimney, but an outer cylinder of glass larger and taller than the first; the glass-holder has an aperture in it, connected by a mouthpiece with a metal tube, which serves as a ventilating flue, and which after passing horizontally to the centre of the chandelier, there ascends to produce draught and carry off the burnt air.

Fig. 1.—*a*, is the burner; *b*, the gas-pipe leading to the burner; *c*, the glass-holder, with an aperture in it, opening into the mouth-piece *d*,



which is attached to the metal chimney; *e*, the ordinary glass chimney; *f*, an outer cylinder of glass, closed at the top by a plate of mica, *g*; or, still better, by two plates of mica, one resting on the top of the glass, and

the other one, *h*, dropping a short way into it. They are connected together by a metal screw and nut, which keeps them a little apart from each other; thus forming a stopper, which cannot be shaken off the glass chimney, but is easily lifted on and off by the small metal ring or knob at the top; *i*, is the metallic tube chimney; *k*, a ground globe, which may be applied to the lamp, and which has no opening, except the hole at the bottom, where it rests on the glass-holder; but any other form, as a lotus glass or vase, may be substituted at pleasure.

Fig. 2, is a plan of the glass-holder, showing the burner *a* in the centre, perforated with jets, with openings round it to allow of a free admission of air to the flame—and the aperture, *d*, which opens into the mouthpiece connected with the metal chimney, *i*.

The burnt air and results of combustion take the course indicated by the arrows, and are entirely carried away by the chimney.

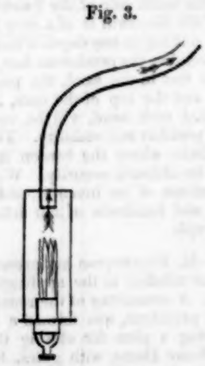
With a lamp burning in the ordinary way, the products of combustion issue from the top of the glass chimney into the apartment; but if the above arrangement be applied, on closing the top of the outer glass cylinder by a plate of mica, all the soot, water, carbonic acid, sulphurous and sulphuric acid, and a portion of the heat, are carried away, and discharged into a chimney or into the open air; and the air in the rooms may thus be kept as fit for the purposes of respiration as if artificial light were not being used.

A curious result of the enclosed lamp is the increase of light produced, amounting, it is stated, to from 10 to 20 per cent., according to circumstances, the same quantity of gas being consumed as before.

This invention is not objectionable in architectural appearance; the ventilation by the lamp is perfect; the heat given to a room is modified, and may be either sustained or diminished at pleasure; the light is increased, and additional safety from accidents is obtained, as in the event of any leakage from the pipes, or from a gas-cock being inadvertently left open, the gas, instead of mixing with the air of the room and becoming explosive, would be carried off by the metal tubes.

Professor Faraday illustrated the principle of the invention by several experiments; first demonstrating that if a lighted taper was applied to the top of a lamp chimney, it would be instantly extinguished, or a glass jar held over it would be immediately filled with air, in which a light could not burn nor any animal exist. If a portion of lime water was poured into the jar it became turbid in appearance, owing to the precipitation of the carbonate of lime, formed by the combination of the carbonic acid with the lime. The sulphurous and sulphuric acids also contained in the water, resulting from the combustion of coal gas, were injurious to metals and to articles of furniture. He then explained that at his suggestion, the gas-lights of the chandelier in the Library of the Athenæum were ventilated by tubes dipping into the lamp glasses, Fig. 3, and conjoining at a short distance above into one central pipe, which carried away all the burnt air from the room.

Fig. 3.



This first application had demonstrated the correctness of the theory, and had induced modifications which had been described in the paper.

The Professor then stated that his attention had been directed to the subject also by the disadvantages attendant upon the want of ventilation in the lanthorns of Lighthouses, as in consequence of the condensation of the products of combustion upon the windows, the intensity of the lights was diminished to a serious extent, and the quantity of carbonic acid in the lanthorns was at times so great that the keepers could with difficulty enter them. This was illustrated by an experiment, showing the difference between allowing combustion to give its products to the air of a room, and carrying off those products freely to the exterior. A short wax candle was placed burning on a plate, a glass jar put over it; and the upper aperture of the jar closed by a globular cork, through which was passed a piece of glass tube, about half an inch in diameter and twelve or fourteen inches long: the tube descending to the top of the candle flame, and being placed just above it. Under these circumstances, plenty of air passed into the jar between its edges and the plate, and out by the tube, to supply all that was needed for combustion, and to keep the glass chamber clear: therefore, in that position it would burn for any length of time, and the jar remain quite bright. But on moving the cork a little, so that the tube should no longer be over the flame, all these results changed, though the air-ways remained exactly as before. The candle then gave the products of its combustion to the general air of the glass chamber, which immediately became dull, from the water deposited upon it, the air itself was deteriorated, the light grew dim, and in a few minutes it went out; but if that was prevented, by the tube being again placed over it, signs of recovery appeared, the light resumed its former brightness, and after a short time even the dew disappeared from the glass, demonstrating how indispensable a perfect ventilation was for lighthouses: on which subject the Professor promised a communication.

Mr. Bethell remarked that the inner chimney appeared to become dim after the light had burned some time.

Professor Faraday explained that this might arise from several causes; he apprehended it was chiefly occasioned by the action of the sulphur in the coal gas upon the ingredients of which the glass chimney was composed. In oil lamps the same effect was observed, but not so speedily as with coal gas. The Trinity House suffered much by it, and had made experiments on various qualities of glass for the chimneys of the lamps of lighthouses. Chimneys formed of mica would not be so affected, but they were not so transparent as glass.

Mr. Bethell said that the Bude light, as now used in the House of Commons, was constructed somewhat on the same principle as had been described in the paper, except that the current was directly upward, which rendered the application of two chimneys unnecessary: perfect ventilation was obtained by it.

Professor Faraday said that the Bude light, as proposed to the Trinity House, was an oil lamp, supplied with oxygen by an apparatus for generating it. In lighthouses it was indispensable that the lamps should be so arranged that the lights should consume only a given quantity of oil, and retain an unvarying degree of brightness for a given time, which was now four hours, at the end of which time they were trimmed. It was found that with the Bude light, the quantity of oil consumed was greater, and the lamps required trimming in two hours, in consequence of the wicks charring; these circumstances rendered the system inapplicable to lighthouses. Subsequently, five of the Bude light lamps had been referred to him by the House of Commons for experimental purposes, and his observations upon them were of the same nature.

Mr. Bethell explained, that in Mr. Gurney's present "Atmospheric Gas-burner," the supply of oxygen alluded to by Professor Faraday was not used.

Mr. Snow Harris inquired whether the action of carbonic acid, to which the term "poisonous" had been applied, was to be considered as positive or negative. How was it to be viewed in its connection with the circulation of the blood and with the process of respiration?

Professor Faraday replied by quoting from the work of Dr. Marshall Hall, that "It was first distinctly stated by Sir Humphrey Davy, that in inspiration and during the pulmonic circulation, the double function was performed of—1st, the absorption of oxygen, and 2nd, the exhalation of carbonic acid, by and from the circulating blood, a doctrine from which another doctrine flows, *viz.*, that, during the systematic circulation, the oxygen absorbed is continually undergoing the transition into carbonic acid." The general conclusion from his experiments was, "That respiration was a chemical process, the combination of phosoxygen (oxygen) with the venous blood, and the liberation of carbonic acid and aqueous gas from it."

Professor Graham, in a note to Dr. Hall, says, "If an animal were to breathe atmospheric air to which carbonic acid were added, in proportion to this addition, the evolution of carbonic acid from the blood would, in my opinion, be impeded; the passage of the carbonic acid outward, at all from the blood, depending upon the comparative absence of that gas from the air taken into the lungs."

In treating of "asphyxia," Dr. Hall says, "The absorption of oxygen, or the evolution of carbonic acid, or both, are impeded or interupted in every case of asphyxia. From the want of oxygen the blood is deficient in stimulus; by the presence of carbonic acid it is positively poisonous."

It appeared from the researches of physiologists, that the presence of a certain proportion of carbonic acid was necessary to stimulate the action of the heart, and regulate the circulation of the blood; that nature kept up the proper supply for this purpose, but that any excess was prejudicial.

Acting upon this principle, Dr. Payerne had brought forward a proposition for purifying the air in a diving-bell, so that without using the air-pump the diver might remain under water for four hours, or even longer. This was, the professor believed, accomplished by decomposing

the carbonic acid, absorbing the carbon, and eliminating the oxygen, and not by generating oxygen, as had been generally imagined.

On the Formation of Embankments for Reservoirs to retain Water. By Robert Thom, M. Inst. C. E.

After describing a model, designed to show that the proper slope for reservoir embankments should not be less than three to one on the water-face, and remarking that waves act more severely on the pitching or paving of the inner face, in proportion to the steepness of the slope, the author proceeds to describe in detail the mode of forming embankments. The foundation is excavated to such a depth as is found firm and capable of preventing the passage of water, then spreading alternate layers of puddled peat, or alluvial earth and gravel, and beating them together with wooden dumpers, until they are completely mixed; the slopes are covered with a puddle made with small stones or furnace-cinders mixed with clay, so as to prevent the possibility of moles or other vermin penetrating into the embankment. He condemns the practice of forming embankments with puddle-trenchers, and refers to many reservoirs made by him at Greenock, Paisley, and elsewhere, the banks of which have stood the test of time without having any puddle-trenches in them, and particularly mentions one at Greenock which remained firm and sound, after a rush of water passing over it at a height of ten feet, caused by the breaking down of the embankment of a reservoir situated about 150 yards above it. He recommends, instead of the puddle-trenches, that the whole of the inner part of the embankment should be made water-tight during the formation of it, by which means it will more effectually resist either any casual injury, or any effect of the swelling of the puddle-trench. The paper is entirely of a practical nature, and is intended to illustrate the author's peculiar views founded on his long experience. It is accompanied by a diagram of the model used in his experiments.

A Pressure-Gauge was presented for the Museum of the Institution by Alfred King, M. Inst. C. E.

This gauge, which has been used at the Liverpool gas-works for more than ten years, for indicating small amounts of pressure, consists of a close cistern containing water, in which is a cylinder having in it a hollow float, connected with a balance weight, by a fine silken cord, passing over a pulley, on the axis of which is fastened a pointer, one end of which marks the amount of pressure upon a dial divided in such a manner, that as each division is equal to a column of water of 1-10th of an inch, a difference equal to 1-50th, or even 1-100th of an inch, may be estimated.

The action is very simple, the float being elevated by the rising of the water within the cylinder, when the surface is depressed in the cistern by the pressure of the current of gas from the inlet pipe.

The description was illustrated by a diagram showing the internal construction of the gauge.

MISCELLANEOUS.

New Rails for Roads.—A discovery has been made in France, that Kaolin clay mixed with a metallic substance forms a compound more durable than iron, and admirably adapted for the rails of railroads. Experiments are being made in England upon the use of wood prepared by Payne's process for the same purpose, and as far as can be ascertained from the trial already made, there is a great probability it will be found suitable for the purpose.

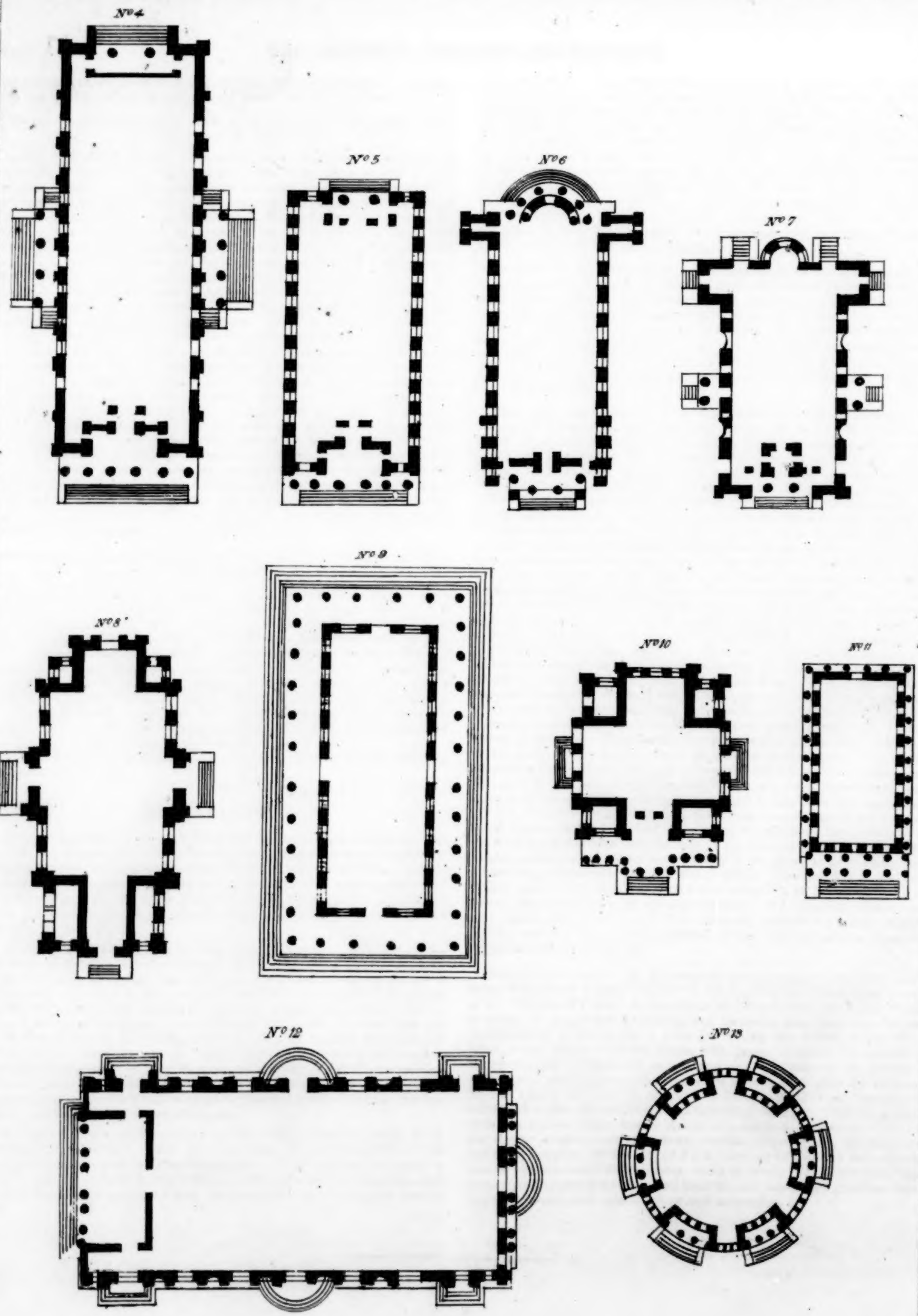
Isthmus of Panama.—The long meditated project of piercing the Isthmus of Panama, for the junction of the two great oceans, is daily more and more attracting the attention of nations, as its importance is continually enhanced by the new relations which the gigantic conquests of discovery abroad and science at home are establishing between the various portions of the globe. In addition to the active inquiries and experiments, in which, as is well known to our readers, both England and America have long been engaged with this view, the French government has now dispatched a mining engineer of distinction, M. Napoleon Gazella, to make a careful examination of the isthmus, and report on the most eligible direction which a canal of communication between the Atlantic and Pacific can take.—*Athenæum.*

Artesian Well in Westphalia.—At a recent meeting of the Paris Academy of Sciences, a letter was read from M. de Humboldt, on the boring for an artesian well in Westphalia. It is intended, he says, to bore to a depth of 2000 metres (about a mile and a quarter English), and at that depth it is supposed that the water will be of the great heat of 70° centigrade. The borers have reached to a depth of 622 metres. To that depth the increase of temperature had not followed the ordinary law, which, according to M. de Humboldt, resulted from the cooling of the column of atmospheric air by the waters of filtration from above; but having arrived at 622 metres, the ascensional force was sufficiently great to force back the water from above, and the ordinary law was re-established. M. Arago announced that it was the intention of the French government to form an artesian well in the *Jardin des plantes.* It is intended to be 900 metres, that is, 200 metres deeper than the Grenelle, and a temperature of 31° centigrade is anticipated. The water will be employed to heat the hothouses of the gardens, and to supply the hospitals of La Pitié and La Salpetriere.

Beton.—M. Vicat states in a communication to the Paris Academy of Sciences, that a béton composed of lime and artificial pouzzolane, when used on the coast of the Mediterranean, undergoes a change, not observed on other shores, destructive of its properties as a cement. In inquiring into the cause he was lead to analyse the waters of the Mediterranean, and found that they contain 7·02 of sulphate of magnesia, and that those of the channel contain only 2·29. M. Vicat points out various modes of varying the composition, according to the situations in which it is to be employed.

The New Iron Beacon for the Goodwin.—In consequence of the strong winds which have prevailed during the last week, it has been found impossible to plant this ingenious invention upon the Goodwin, which was intended to have been accomplished by the use of a chain lighter, to have been brought down by the Tartarus, Captain Bullock, R.N. Unfortunately, however, the weather having proved adverse, the Lords of the Admiralty have expressed their opinion that the season is too far advanced safely and properly to plant the beacon; and they have therefore deferred doing so until the spring. This beacon, which has cost the inventor no little pains and expense to mature, is what we shall term, after his own language, "ponderous footed;" and it consists of a cast iron chamber, 6ft. 6in. high by 4ft. square, terminating in a solid point, and weighing about 4 tons. Within the chamber there is contained a socket, which is strengthened by iron brackets. In this socket is fixed five feet of the circular shaft of the beacon, which is made of inch-iron, cast hollow, the diameter of the lower part of the shaft being seven inches, and of the upper six. The two portions of the beacon are united by a flange and core; and the entire height from the top of the chamber to the mark, is 27 feet. The mark is an ellipse, 6 feet by 4 in diameter, composed of round bars of wrought inch iron, strongly secured to the shaft by a flange and core, constructed so as to form a most conspicuous beacon, and also to offer the least possible resistance to the action of the wind. Next spring, by the direction of the Elder Brethren of the Hon. Trinity Board, it will be planted at the eastern end of the dangerous Goodwin, on the south side of the Swatchway into Trinity bay. The sand at this part of the Goodwin is of a very hard and compact nature, so as to render the sinking to any depth a task of no very easy completion; but it is expected that the ponderous foot, or base of the beacon, being inserted some nine feet in the sand, the pressure from without of the sand upon the sides and the top of the base, in addition to its own weight (which, when filled with sand, will be upwards of 6 tons), will secure its perpendicular position and stability. The firmness of the sand at this part of the Goodwin, where the beacon is to be placed, will, of course, be favourable to its ultimate security. We hope that this beacon may answer the expectations of its inventor, and be the means of preserving many a vessel, and hundreds of our fellow-creatures, from destruction.—*Dover Telegraph.*

Bridges at Paris.—M. Fourneyron has presented to the Paris Academy of Sciences a paper relative to the application of floodgates to one of the bridges of Paris. A committee of the municipal council of Paris, of which M. Arago was president, was formed a long time ago for the practicability of discussing a plan for closing the arches of the Pont Neuf, or the bridge of Notre Dame, with gates, by which the current of the river could be regulated at will, and which, by raising the level at a certain part, would give a fall of sufficient force to work powerful turbines for the supply of water to all parts of Paris. In 1841 M. Fourneyron submitted a plan of gates of such construction that they could be worked with ease by one man; but as it was impossible to pronounce fairly on the merits of his invention without absolute experiments, the Academy and the committee of the city of Paris resolved to suspend the expression of opinion until experiments could be tried. M. Fourneyron now announces that for more than two months past one of the gates has been in use at Gisors, and that it has proved successful.



PLANS OF THE MODEL CHURCHES PRESERVED IN WESTMINSTER ABBEY.

Newsworthy & Wells Litho. Union St. Moor Lane. City